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A Breeding Problem of Sheep in the South-West Division of Western Australia.

By H. W. BENNETTS, E. J. UNDERWOOD and F. L. SHIER.

DURING the past few years a specific breeding problem in the ewe has assumed very serious proportions throughout the areas of early-subterranean clover pasture development in this State. It is not confined to the Merino breed, but this breed is predominantly affected. The problem has three manifestations, infertility, dystokia ("dead lamb trouble") and a prolapse of the womb (uterus) which generally occurs some months after the lambing season and which may affect even unbred animals. Analogous conditions do not appear to have been described previously in veterinary literature and have not been reported from outside this State except for some isolated occurrences recently met with on Kangaroo Island, and in other parts of South Australia which have been reported by McKenna (1944 and 1945).

On present evidence occurrences appear to be associated exclusively, or almost exclusively, with pastures of the locally developed Dwalganup strain of early-subterranean clover.

Rams bred and maintained on "affected" properties have not been found to show any apparent abnormalities. The castrated male and the unbred female, however, may exhibit extraordinary phenomena which throw some light on the nature of the problem under consideration. Wethers, not uncommonly, may secrete milk or show extraordinary "feminine" changes in their sex organs; marked udder development and copious milk secretion are quite commonly seen in maiden or unbred females.

Following field and laboratory studies in 1943, reported by Bennetts (1944), the complexity and serious import of the breeding problem was realised and a more intensive attack was planned.

An Investigation Committee, comprising Dr. L. B. Bull and Mr. A. J. Vasey, of the Animal Health and Production Division of the Council for Scientific and Industrial Research, and the three authors was formed early in 1944 and has since directed the co-operative investigation being carried out on a comprehensive scale by a team of workers in this State.

Bennetts, H. W. (1944)—J. Agric. West Aust., 21 : 40.
McKenna, C. M. (1944 and 1945).—Private communications.

The cause is, of course, unknown, although it may be suggested that the infertility and dystokia result from hormone imbalance related, in some way, to effects of depasturage on the early strain of subterranean clover, *Trifolium subterranean L.* var. Dwalganup. The hormones referred to are chemical substances produced in certain glands of the body which control reproductive processes.

The data given in this paper are based on information from some seventy properties throughout the affected area and on experimental evidence which will be detailed in later publications. Most of the properties concerned have been visited by us, many on different occasions during 1943-45, and on several properties field experiments have been carried out during the period specified.

1.—DEFINITION.

Infertility.—This condition is an infertility of the ewe occurring on subterranean clover pastures, in association with dystokia or prolapse, or with both and is characterised by failure to breed, despite repeated services by known fertile rams, and by an abnormality known as cystic endometrium, which means a cystic condition of the lining of the uterus. The infertility appears to result from the ovum or egg not being fertilized by the ram's sperm.

Dystokia.—The condition referred to is a maternal dystokia which results apparently from inactivity of the uterus, and is characterised typically by lack of evidence of external signs of imminent lambing and by the death of the full term foetus. In some instances lambs are born dead, but more commonly, the foetus is not delivered, and may be dead for some days before it can be seen externally.

Prolapse.—The condition referred to is a prolapse of the inverted uterus proceeding to complete inversion (turning inside out) which occurs typically, some months after the lambing season. Ewes not bred that season or even young virgin females may be affected.

2.—OCCURRENCE, DISTRIBUTION AND ECONOMIC IMPORTANCE.

The three manifestations, infertility, dystokia and prolapse, are closely associated in their occurrence and distribution throughout the affected region, but there is considerable variation in their relative and absolute economic importance on individual properties.

The development of the problem on a property may be heralded by the dramatic appearance of dystokia followed by infertility. Less commonly the first evidence is an insidious appearance of infertility or prolapse. All three manifestations may, in some cases develop serious proportions at the same time, although a high incidence of prolapse is rare.

Whatever the onset, however, the inevitable result appears to be that within a shorter or longer period of years, the infertility becomes progressively more serious until breeding is discontinued as unprofitable. The nature of this infertility had not been studied nor was its relationship clearly defined when Bennetts (*loc. cit.*) studied the more dramatic manifestations of dystokia and prolapse.

Although a few individual properties were known to be affected for some time prior to 1941 it was not till then that there was much evidence of a serious problem developing in the clover areas. The breeding problem thereafter has become progressively more serious and widespread. It is now general throughout the whole area of early-subterranean clover development from as far south as

Mt. Barker, Boyup Brook and Kojonup, west of the Great Southern railway to Beverley in the north. This is the main area affected, but there are increasing occurrences in an area immediately north of Perth, and again in the Geraldton district 300 miles north of Perth. In both these areas early-subterranean clover pastures are well developed. Present evidence indicates that the problem may be expected in any area where early-subterranean clover pastures are well established. It is true that there are still some properties within the area with good clover pastures, developed for varying periods of time, which, as yet, show little or no evidence of a breeding problem. On the other hand experience suggests that none of these properties can be regarded as "immune."

The economic aspects of the problem are extremely serious. Not only is there a heavy annual loss from wastage of ewes and lambs in ordinary farm flocks, which virtually rules out sheep breeding, but the affected areas contain many of the best stud Merino flocks in Western Australia. The loss of valuable animals from these flocks will have serious effects on the productivity of sheep throughout the State. In addition considerable areas of virgin and undeveloped country exist throughout the affected region, and which are capable of very great development. Pasture improvement and development of such country is being held up pending a practical solution of the breeding problem. There are already approximately two million sheep carried within the affected region of which about 50 per cent. are breeding ewes. These are principally Merinos, but large numbers of crossbred and other breeds of sheep also exist.

3.—TYPE OF COUNTRY AND METHODS OF HUSBANDRY.

No detailed soil surveys of the affected areas have yet been made, but it is evident that the soil types vary considerably and range from what are popularly known as "light" soils of low fertility to much heavier soils, producing excellent cereal crops, and which previously were regarded as very "sound" for stock. The main affected area south of Perth, where the incidence of the breeding problems is most intense, carries Wandoo (*Eucalyptus redunca* var. elata) as its principal timber.

The soils are generally grey sandy or gravelly types. In the affected area north of Perth the clover development may be either on typical "sand plain" soils which normally carry little or no grazing, or on heavier textured red-brown soils carrying York Gum (*Eucalyptus foecunda,* var loxophleba) and jam (*Acacia acuminata*).

The average annual rainfall over most of the area is about 20 inches, most of which falls between May and October. Until recent years there was little improved pasture and the type of husbandry was either Merino-sheep grazing over extensive areas, or cereal growing and grazing of sheep on stubbles and "volunteer" pastures. These pastures consisted largely of relatively unproductive annual species such as capeweed (*Cryptostemma calendulaceum*), wild geranium (*Erodium botrys*), *Bromus spp.*, *Festuca spp.*, and a number of small clovers. With the introduction of the early (Dwalganup) strain of subterranean clover about fifteen years ago, and on an increasing scale ever since, a marked improvement in the pastures has taken place and an enormous increase in productivity of the area. This strain of clover has proved to be extraordinarily well-adapted to the environment. It appears to require only regular treatment with superphosphate to make luxuriant growth. Over much of the area the pastures are now completely dominated by subterranean clover and in many cases the rest of the plant species together contribute less than five per cent. of the total weight of herbage.

As a result of this remarkable development of clover pasture the farm husbandry of the area has been revolutionised. Productivity has been trebled or quadrupled, very little cereal cropping is now carried out, and the stock are maintained almost exclusively on the clover pastures, supplemented in some cases by clover hay during the summer and autumn months. Merino sheep, many of the flocks of very high quality, are the principal stock carried. There is little fat-lamb raising from crossbred ewes, but baby-beef production is becoming increasingly popular.

4.—INCIDENCE.

As indicated earlier the relative incidence of the three manifestations of the breeding problem varies considerably from property to property and from time to time although the general progress is towards a high degree of infertility reached within a few years of the first appearance of trouble.

Quite commonly the incidence of dystokia is, at some period, high, accounting for the death of 30-40 per cent. of lambs carried to full term and for the death of 15-20 per cent. of all ewes mated. The incidence in the more susceptible age groups, notably ewes first mated at 2½ years, may be considerably higher, e.g., a 70 per cent. lamb and a 40-50 per cent. ewe mortality. There is, of course, a considerable additional ewe wastage due to retained foetus or inflammation of the uterus or both resulting in general ill-health and loss of breeding capacity.

The incidence of the infertility, in affected flocks shows a general tendency to increase progressively from year to year resulting in a reduction of lambing percentage, estimated at tailing, from the normal of about 80 to about 30 per cent. or even to less than 10 per cent. Breeding operations are often relinquished before such a low stage of fertility is reached.

The incidence of prolapse is rarely as serious although in some flocks it has reached 10-12 per cent. and has constituted the principal or only phase of the breeding problem experienced for one or two years. More commonly the yearly incidence is from less than 1 to 2 per cent.

(i) *Seasonal Occurrence, Yearly Variation and Pasture Condition.*

Infertility, dystokia and prolapse only became manifest as a general problem in the areas of early-subterranean clover development subsequent to 1940; the initial rapid extension of the problem in 1941-1943 coincided with the occurrence of three unusually good seasons favourable to a prolific and dominant growth of clover, and an exceptionally prolonged green-feed period. It was at first thought that such conditions directly influenced the incidence of infertility and dystokia. Subsequent experience during the years 1944 and 1945, when the seasons have been shorter and less favourable has failed to confirm this view; during these last two seasons there has been a progressive deterioration in lambing percentages due to infertility and dystokia on individual properties previously affected, as well as a marked extension to properties previously unaffected. There is some evidence however that "good clover years" favour the incidence of prolapse, which condition occurs principally in the spring, viz. from late August till the feed dries off in October. In some years it occurs as early as July and occasional cases are seen throughout the summer, but an examination of some of these suggests that they are recurrences of earlier cases which had not progressed or had "recovered" spontaneously.

With regard to the influence of pasture composition on the incidence of infertility, dystokia and prolapse the earliest and most severe incidence was on properties where subterranean clover was the dominant, or almost exclusive, pasture

species, and it was considered that clover dominance was an essential feature of the problem. It has become evident recently, however, that the same breeding problem is developing, although not yet to the same degree, on pastures less highly improved or in less favourable environments, where early subterranean clover constitutes as low as 30 per cent. of the general herbage on the property. Even in these cases however it cannot be asserted that the sheep have not had access to clover dominant pastures during some periods of their life, as the pasture composition varies considerably on different parts of the property and in different seasons.

The age of establishment of subterranean clover pastures appears to have little relationship to the occurrence of the problem. On some properties pastures have been established for ten years or more before any disease in the sheep became manifest, whereas in other cases the breeding problem has become evident in its various phases within a year or two of the sowing of subterranean clover.

It is notable that the subterranean clover is palatable to sheep only in the mature and dry stages. On dominant pastures, however, the sheep must of necessity subsist almost exclusively on this plant throughout the year. The palatability of the clover burr itself appears to vary in different localities; on some properties it is relished, on others "sheep will starve rather than eat it."

(*ii*) *Species of Animals Affected.*

The sheep, so far, is the only species of farm animal known to be affected. Cattle and horses bred and maintained on "affected" properties have shown no evidence of any corresponding problem.

(*iii*) *Breed and Sex.*

Although the Merino is the dominant breed within the area there are a number of "affected" properties where other breeds, notably crossbreds, constitute a proportion of the flocks raised. The evidence from these, in particular, indicates that the Merino is very much more susceptible to dystokia and infertility than is the crossbred (Romney Marsh, Border Leicester or English Leicester x Merino). Information regarding pure British breeds is rather limited.

The incidence of prolapse, however, appears to be quite uninfluenced by breed.

With regard to the male, the results of mating observations indicate that the infertility of the ram is unimpaired. Wethers on the other hand not uncommonly exhibit milk secretion and develop an accessory organ ("false bladder") which will be described later.

(*iv*) *Age.*

A survey of records indicates that the Merino maiden four-tooth ewe group (mated at 2½ years) consistently shows the highest incidence of dystokia although the incidence is not confined to any age group.

The infertility may affect breeding ewes of any age. The maiden two-tooth, for ewes are commonly mated at one and a half years in the subterranean clover areas, appears to be the least susceptible age group. For example, on property "R" the two-tooth lambing percentages were 90, 90 and 70 during the years 1943-1945 inclusive whereas the corresponding lambing percentages were 69, 40 and 39. These low percentages are largely the result of infertility although dystokia was contributory.

Prolapse is met with in ewes of any age, but the incidence appears to be much lower in ewes below two years old; cases have been reported in lambs 3-4 months old but the only one we have examined proved to be a prolapse of the vagina only.

(v) *Condition.*

Sheep bred and maintained on subterranean clover pastures generally carry high bodily condition almost throughout the year and it was widely considered by farmers that high condition, unusually marked in the years 1941-1943, contributed to the incidence of dystokia and infertility. Observations and experimental studies carried out by us, subsequently, have given little evidence in support of this claim.

The possible influence of bodily condition on the incidence of prolapse has not been investigated. Prolapse occurs both in ewes which have bred and ewes which have not bred during the preceding lambing (May-June). The data available is insufficient, however, to indicate whether breeding does or does not affect the subsequent incidence of that condition.

5.—SYMPTOMS.

This account of the clinical features or symptoms of dystokia, infertility and prolapse is based on the examination of large numbers of affected animals observed during the period 1943 to 1945 in the course of investigations on affected properties, and from observations on experimental groups, some mated with raddled rams, maintained on affected properties or at State Research Stations (Beverley and Merredin).

(i) *Dystokia.*

Dystokia is here used in a restricted sense to describe a specific condition which differs, clinically, from the familiar type not uncommonly affecting a small percentage of ewes in the flocks and which is usually due to abnormal size or position of the lamb. The condition here considered is a maternal dystokia characterised by ephemeral labour and failure of the ewe to show concern or discomfort prior to the advent of complications resulting from the death of the foetus. Towards the end of the in-lamb period the appearances of the body and a degree of udder development indicate that the ewe is pregnant and due to lamb. At term, however, there is only a feeble and brief period of labour, frequently when the ewe is in the standing position. This results only in rupture of the foetal membranes (water bag) and escape of the foetal fluids. Following this almost momentary attempt at lambing no further effort is apparent, and the ewe unconcernedly rejoins the flock.

Quite commonly there is no external evidence of the foetus at this stage and very careful and prolonged observations are necessary to find these early cases in the paddock; delivery is then accomplished relatively easily although the lamb, in most instances, is already dead.

In general the ewe is not noticed to be in trouble till some days later when the feet or portion of the head of a dead lamb is noticed protruding from the vulva. Other signs are, humped attitude, occasional abdominal straining, the presence of a functioning udder greatly distended with milk and, not uncommonly, attempts to foster young lambs. At this stage the foetus is generally more or less decomposed, the uterus is dry, the vulva-vaginal canal ("the passage") has contracted and delivery is accomplished only with difficulty; an inversion of the uterus, not related to the manifestation "prolapse" which occurs in the spring months, is a common sequel.

Ewes affected with dystokia, are frequently not noted till some weeks or months later when the flock is brought in and handled. The signs then noted are putrid vaginal discharge, general ill health, abnormal posture and occasional

straining. In some cases the only evidence may be the palpation of a mummified foetus through the abdomen; the actual discharge of foetal remains through the abdominal wall has been reported.

This is the usual picture in the flock. Less commonly a large proportion of ewes affected are able to deliver the full term foetus although the lamb is born dead. The birth of a high percentage of dead lambs is sometimes a feature during the first year of occurrence of dystokia in the flock. It is considered that both manifestations described merely represent different degrees of a maternal dystokia resulting from uterine inertia and leading to death of the full term foetus because of delayed parturition or non-delivery.

(*ii*) *Prolapse.*

The prolapse referred to is a prolapse of the inverted uterus proceeding to a more or less complete inversion of the organ. The earliest stage, revealed by careful observation of the flock, is the ewe lying down bleating and straining as though attempting to lamb, this being followed by the early appearance of prolapsed uterus and cessation of straining. The affected animals, however, are rarely noticed until the prolapse is obvious externally and we personally have seen very few cases at an earlier stage. After the prolapse is apparent externally the condition develops progressively until, within a week or two, the body of the uterus is completely, and the horns are partially, inverted. The prolapse projects from the body as a swollen tube up to ten inches long by three inches in diameter terminating in partially inverted horns. The exposed lining is at first highly inflamed and red but later becomes grey, dead and eroded. The initial swelling and great enlargement of the organ subsides.

Affected animals are usually slaughtered when found. If not, they may survive for months or die from infection, toxaemia or from the effects of rupture of the prolapsed uterus. Attempts at replacement of the prolapsed organ and its fixation by various methods adopted by sheep owners are not generally successful. This is to be expected in view of the great stretching and weakening of the supporting ligaments.

Spontaneous "recovery" is known to occur but it is doubtful if the "recovery" is permanent; recurrences have been seen some months later in such cases and it is suspected that they are not uncommon. It is difficult to understand how a well developed prolapse can reduce spontaneously but we have definite evidence that this does happen.

(*iii*) *Infertility.*

The infertility has no characteristic clinical features. Observations carried out on experimental sheep from "affected" properties indicated that there was no failure of oestrum (heat). Infertile ewes came in more or less regularly to service but did not get in lamb. The infertility appeared to be due to failure to conceive. Ten of the experimental ewes were killed within a few days of the last of a number of apparently infertile services. None showed any evidence of conception having occurred. From four killed 4-6 days after service unfertilized ova (eggs) were obtained from the tubes or uterus. On present evidence it appears therefore that the infertility results from failure of fertilization of the ovum. It is not unreasonable to assume that this is due to the unfavourable influence on sperm activity of a cystic endometrium, a constant abnormality in infertile ewes examined so far.

6.—PATHOLOGY.

A more complete account of the pathology, i.e. the changes in the organs revealed by naked eye and microscopic examination, is given in another publication by Bennetts, Underwood and Shier (1946)*.

A summary of this information is adequate for the present purpose.

In order to study any abnormalities present in ewes in affected flocks a detailed examination was made of the following animals slaughtered for the purpose during the period 1943 to 1945:—Fourteen cases of infertility, 15 cases of dystokia, 23 cases of prolapse and two groups each of 50 apparently healthy young ewes selected at random from flocks on two properties where the breeding problem was being studied. The cases of infertility, dystokia and prolapse were obtained from several different properties.

A detailed examination of the genital and other organs revealed no significant or constant abnormalities other than the frequent occurrence throughout the series of a cystic endometrium. In some cases the uterus contained a colourless fluid as much as one ounce being seen (hydrops uteri).

The cystic condition varies considerably in degree. In some cases, particularly in known infertile ewes, on opening the uterus large and numerous cysts are seen just below the inner lining of the organ. These have the appearance of raised blisters containing fluid. A cut through the wall of the organ shows that it is honey-combed with these cavities containing fluid. These cysts may be up to three-fifths of an inch in diameter. More commonly, however, the cysts are quite small (1/10th in. to 1/25th in. in diameter) and only a few may be visible so that the abnormality is missed unless a careful examination is made. In other cases the abnormal condition of the uterus is revealed only by microscopic examination. The results of this study indicate that cystic endometrium is common in flocks depastured on affected properties; that ewes may be affected at an early age (14 months) and that the numbers affected and the severity in the individual increases with age.

Cystic endometrium is well known in women and has been extensively investigated both in humans and experimental animals. The occurrence of the same abnormality in ewes in affected flocks is therefore a valuable indicator of the possible nature of the causal factor or factors operating in the breeding problem under investigation.

In this connection valuable supporting evidence is provided by the observation that udder development and milk secretion in both maiden and unbred ewes commonly occurs in affected flocks depastured on early-subterranean clover. This phenomenon is noted during the spring and early summer months when udder development may be marked and milk secretion copious, particularly in favourable seasons (e.g. 1942 and 1943).

It may be stated here that a bacteriological examination of ewes affected with infertility, dystokia and prolapse has given no evidence that the breeding problem is of infectious origin.

7.—MILK PRODUCTION AND "FALSE BLADDER" IN WETHERS.

The above conditions which occur on early-subterranean clover properties are important not so much from economic considerations, but because the nature of the changes involved throws further light on the probable cause of the associated breeding problem of ewes.

*Bennetts, H. W., Underwood, E. J., and Shier, F. L., (1946).—Aust. Vet. J., in press.

For this reason a brief description of these extraordinary manifestations is included. Their significance will be discussed later.

(*i*) *Lactation in Wethers.*

This has been reported from a number of early subterranean clover properties, particularly in the spring of 1942 and 1943 when "the shearers were squirting milk on the board." It was stated that on one property, in 1942, some 300 wethers, about eight per cent. of the total carried, showed evidence of lactation. The owner estimated that in some cases there was about half an ounce of secretion.

We had no opportunity of investigating the phenomenon until October, 1945, when we examined a number of subjects on several properties. There is a more or less marked development of the teats with secretion into a closed space bounded by the teat wall and above by a capsule which covers the base of the teat; there is no udder development, but the milk is secreted by tissue lining the teat wall. There may be as much as half an ounce of secretion contained in each teat. It resembles ewe's milk in appearance and has a similar chemical constitution.

The degree of the teat development may correspond to that of a ewe in full lactation, e.g., in one case the teats were 2½ in. long and 2 in. in diameter at the base.

(*ii*) *"False Bladder."*

This extraordinary phenomenon consists essentially of the almost incredible development of a new accessory organ in the form of a large sac which communicates with the urethra (the tube leading from the bladder to the penis) and which thus becomes filled with urine.

This sac, up to 6 in. in diameter, may almost completely fill the pelvic cavity and is visible externally as a large fluctuating swelling which may bulge out the whole region of the crutch below the anus. In some cases this sac may rupture through the skin and, particularly when the normal passage is blocked as a result of stones or an inflammatory process, the urine may be voided from this opening in the lower portion of the crutch.

The condition described becomes apparent during the spring when the wethers affected may be recognised by reason of loss of condition and the presence of the swelling mentioned. They frequently give evidence of being in pain. Wethers do not usually survive for many weeks after the affection is first recognisable; they lose condition rapidly and die as a result of toxaemia or infection.

Reports indicate that the condition described is not uncommon on early-subterranean clover properties and that it is restricted to them. The reported occurrence of clinically recognisable cases is low, the highest reported being two per cent. on one property.

The significant feature of this condition from a scientific point of view, is the structure of the wall of the sac. The nature of the membrane lining is identical with that of the female vagina. This, as well as other highly significant (metaplastic) microscopic changes in the male sex organs points to the influence of some "feminising" agent, the probable nature of which will be discussed later.

8.—DISCUSSION.

The evidence available to the present time indicates that the breeding problem with its three manifestations, infertility, dystokia and prolapse, is of nutritional origin and that a diet of "affected" early-subterranean clover is the principal causal factor.

The abnormalities found in sheep in affected flocks, i.e., a cystic condition of the uterus in ewes, the development of "feminine" changes in the male sex organs and the secretion of milk by unbred ewes and by wethers, are identical in nature with changes known to be produced in humans and various species of experimental animals by an excess of a female sex hormone (oestrogen). This hormone is a substance produced naturally in the entire animal and is one of the important factors controlling the whole reproductive process in the female.

It has been shown further that the cystic condition of the uterus can be produced regularly in guinea pigs fed for some weeks on a diet of "affected" subterranean clover.

It is most probable therefore that the clover contains some substance which causes animals to produce an excess of oestrogen or contains substances which when eaten exert a similar effect to oestrogen in the animal body.

A series of experiments with guinea pigs designed to elucidate the nature of the potent substance or substances present in "affected" subterranean clover is already proceeding. At the same time an endeavour is being made to assess the potency in the plant at different stages of growth.

It remains to be demonstrated also whether the potent substance (or substances) whose presence is deduced from the effects produced, is innate to the Dwalganup strain or is an abnormal product (or products) developed in this and possibly other plants as a result of unfavourable environmental factors, e.g., mineral deficiency or excess in the soil.

Experiments are being carried out also to determine whether sheep can be bred satisfactorily on "affected" properties when the clover pasture is balanced by other herbage, notably oats and wimmera rye grass.

Another series of experiments being carried out with sheep, although not yet complete, has shown definitely that the effects of grazing on "affected" clover persist for at least several months; sheep may remain infertile or may develop dystokia long after they have been removed from clover pastures. This finding is of obvious practical significance.

The results of these series of experiments and of others not referred to, will be published when available.

9.—SUMMARY.

(i) A description is given of a very serious breeding problem of sheep on early-subterranean clover pastures in parts of Western Australia. There are three manifestations of the disease in the ewe: infertility, resulting apparently from failure to conceive; dystokia or difficult birth involving the death of the full-term foetus; and prolapse of uterus occurring generally some months after lambing or even in unbred females.

(ii) Rams remain fertile and apparently quite unaffected, but wethers may show the extraordinary phenomenon of marked teat development and milk secretion. In some cases they develop a swelling below the anus which on post-mortem is found to be due to the presence in the body cavity of a large sac containing urine. This actually has a structure similar to the female vagina.

(iii) Merino ewes are more susceptible to the infertility than cross-breds and on most properties show a higher incidence of dystokia. Merinos and crossbreds appear to be equally susceptible to prolapse. There is little evidence regarding the susceptibility of the British breeds.

(iv) Ewes transferred from "sound" to "affected" areas remain fertile and free from dystokia or prolapse for at least one lambing season. Present evidence suggests that their fertility falls in the second season on "affected" country. Ewes reared on "affected" properties remain infertile or susceptible to dystokia even after transference for at least one season to sound country.

(v) Infertile ewes come into season and take the ram normally but do not conceive. This failure to conceive is believed to be due to a cystic condition of the lining of the uterus (cystic endometrium) which has been found to be constantly present in such ewes.

(vi) The breeding troubles are not due to infection but are of nutritional origin. Strong evidence has been obtained that the "affected" clover contains some chemical substance or substances with an effect similar to that of excess of the female sex hormone (oestrogen).

(vii) Cystic endometrium has been produced experimentally in guinea pigs fed "affected" subterranean clover. Such clover has been preserved in a potent condition and work designed to elucidate the nature of the toxic principle is proceeding. The ability to use guinea pigs will be of enormous advantage in this work.

10.—RECOMMENDATIONS.

It is evident from the summary that considerable knowledge of the problem has already been obtained, but that several years of intensive research will be necessary before this is complete and control methods developed. However, a number of practical suggestions can be made to farmers which, if adopted, should help them to keep the total productivity of affected properties as near their normal level as possible.

(i) Once a low level of fertility has developed in a flock there is nothing the farmer can do to render the barren ewes fertile. It is useless to continue breeding with such ewes. The small percentage of lambs obtained would not compensate for possible losses from dystokia.

(ii) The fat stock market offers a reasonable outlet for ewes of this type which can be expected to be fat in late summer and autumn. Alternatively ewes of good quality could be maintained as pure wool producers. A policy of fattening and wool production with purchased wethers would be satisfactory, but its general adoption is limited by the supply of wethers.

(iii) A breeding programme based on the regular purchase of ewes from "sound" areas could also be adopted. Such ewes have been shown to lamb normally for at least one season after transfer to affected country. For many farmers this would involve a considerable loss of "quality" in their flock, but is the only way in which a breeding programme could be maintained. Aged ewes would obviously be the most suitable for this policy as they are by far the cheapest and would not have the same time to become infertile as younger ewes. If the rams used were of the long wool British breeds such a breeding policy would be very satisfactory from the financial aspect in view of the very strong demand by fat lamb growers for long wool crossbred ewes.

(iv) Fat lamb production for export based on Corriedale or crossbred ewes cannot be recommended with confidence for affected properties (even if the ewes were available) because a number of flocks of these breeds have already given evidence of the breeding troubles and others may become affected in the course of time.

(v) Baby beef production, based on such breeds as the Aberdeen-Angus or Red Poll could be developed with distinct advantage as one of the activities on many affected farms at present carrying only sheep. At the present time this is a very profitable form of production.

(vi) Increased production of cereal crops and the introduction of Wimmera rye grass can also be recommended for many properties where the subterranean clover development has resulted in a marked increase in soil fertility. There is no definite evidence that this will reduce the incidence of the breeding troubles, but it will certainly not increase them, and will result in a more balanced grazing and increased productivity from the farm as a whole.

11.—ACKNOWLEDGMENT.

We are indebted to Dr. L. B. Bull and Mr. A. J. Vasey of the Council for Scientific and Industrial Research, for helpful advice, to the Australian Wool Board, for generous financial assistance, and to many sheep owners throughout the affected area for their ready co-operation.

The Cystic Tapeworms (Bladder-worms) of Sheep.

C. R. TOOP, Assistant Chief Veterinary Surgeon.

WHEN sheep are examined at postmortem, bladder-like structures or cysts containing a clear watery fluid may frequently be observed in the body cavity and in various tissues and organs. These are tapeworm cysts and represent larval or immature forms of tapeworms, the adult form of which is found in the intestine of the dog and other closely allied animals.

Three kinds of tapeworm cysts are found in sheep in Western Australia. Two of these are Cysticerci in which the cyst contains a single tapeworm head. The third is the Echinococcus or hydatid cyst which contains numerous tapeworm heads and frequently grows to a large size. These cysts rarely affect the general health of the sheep and their presence is detected only when the animal is subjected to postmortem examination. Two of them, however, are of considerable importance. Cysticercus ovis is responsible for the condition known as "sheep measles" causing the rejection of lamb and sometimes mutton carcases intended for export. The Echinococcus or hydatid cyst not only occurs in sheep but affects other animals and man, constituting a danger to human health.

The sheep becomes infected by swallowing tapeworm eggs passed out by infected dogs which contaminate the pastures. The dog in turn becomes infected from the consumption of raw offal containing tapeworm cysts. For the control of the parasite it is necessary to break this cycle firstly by the treatment of dogs for the removal of the adult tapeworms and secondly by the adoption of precautions which will prevent the dog from obtaining access to raw offal.

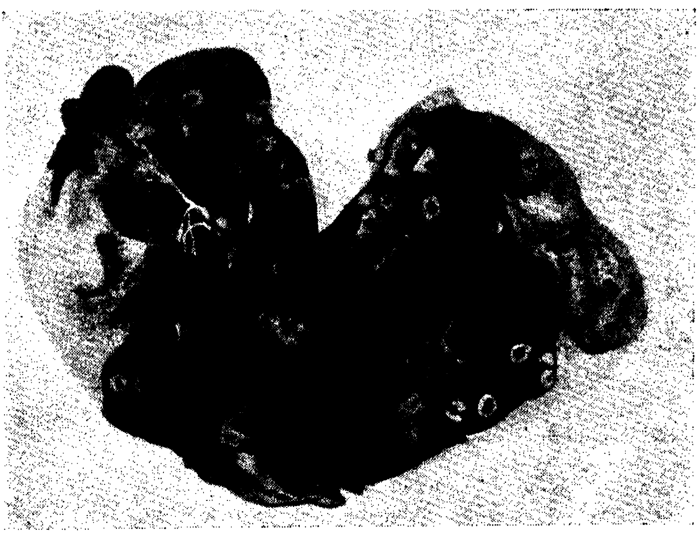
Cysticercusovis—"Sheep Measles."

Cysticercus ovis occurs principally in the heart muscle and diaphragm where the cysts may be present in large numbers. The cysts may also be observed in various locations of the muscular system and in the tongue as well as in the walls of the oesophagus (gullet) and stomach. The cysts are oval in outline and measure about a third of an inch in length by a sixth of an inch in breadth, the

tapeworm head being situated about midway between the ends. C. ovis occurs predominantly in lambs. The cysts undergo rapid degeneration and are much less frequently observed in adult sheep. From the appearance of the tissues in which the cysts are located, the condition is sometimes referred to as "sheep measles."

C. ovis is of quite considerable importance to the export lamb industry. Upon examination, carcases showing evidence of infection, are rejected as unsuitable for export. Such carcases are sold on the local market usually at a reduced figure and with consequent loss to the producer. The incidence of C. ovis infection in lambs varies considerably from season to season. Records which have been kept at the Meat Export Works over a number of years, indicate the average annual rejections from this cause to be in the vicinity of .25 per cent.

It is necessary to mention that the parasite is not transmissable to man and that the presence of cysts in lamb carcases is of no importance in relation to human health.



Cysticercus ovis in the heart muscle of a sheep. (After Drabble.)

Life History.

The adult tapeworm is known as Taenia ovis. It occurs in the intestine of the dog and allied species such as the fox and dingo, and varies in length from about 18 inches to five feet. Like other tapeworms the parasite is flat and ribbon-like and consists of a head and neck and a chain of segments. The head is small and provided with suckers and hooks which enable the parasite to attach itself to the lining membrane of the bowel. The segments are rectangular and increase in size from the head backwards. As the segments mature or ripen, they become detached and are replaced by new segments which form behind the neck. The ripe segments contain tapeworm eggs which are passed out in the droppings and contaminate the pastures over which they may be distributed by the action of wind and rain. The tapeworm eggs are swallowed by sheep while grazing and upon reaching the intestine, the shell is digested and a minute embryo armed with six hooks is liberated. The embryo bores through the bowel wall and gains access

to the blood vessels, being carried to the liver and then to the heart. From this point it passes into the general circulation and is carried to locations such as the heart muscle and diaphragm, where it is detected at postmortem. Here the embryo continues to grow developing into a mature tapeworm cyst after an interval of two to three months. The dog becomes infected by eating raw offal, e.g., the heart, containing tapeworm cysts. Upon reaching the intestine of the dog, the bladder is digested setting free the tapeworm head which becomes attached to the bowel wall. After an interval of about two months, a chain of segments is developed and eggs commence to be voided in the droppings. This completes the life cycle of the parasite. The life histories of Cysticercus tenuicollis and Echinococcus granulosus are similar.

Taenia ovis.—This tapeworm occurs in the intestine of the dog, fox and allied species. The larval form is known as Cysticercus ovis and is found in the heart muscle and diaphragm of the sheep.
[U.S. Dept. of Agriculture.]

Control.

Since sheep become infected by the ingestion of tapeworm eggs voided by dogs, control measures should be directed towards the prevention of infection of dogs together with treatment for the removal of the adult tapeworms.

In order to prevent infection, dogs should never be fed or allowed access to raw offal. Such material may, however, safely be used after boiling for 10 minutes which will destroy the tapeworm cysts. In addition, all dogs on sheep-raising properties should be regularly treated with drugs for the removal of tapeworms. Arecoline hydrobromide is highly effective for this purpose. The drug may be procured in the form of ½ grain tablets. This is the dose for a sheep dog of average size and it may be given either in tablet form or in solution, after the tablet has been dissolved in a fluid ounce of water. In smaller dogs such as terriers, the dose should be reduced to ¼ grain, while in the case of kangaroo dogs and animals of similar size, a dose of one grain may be administered. Treatment should be repeated at intervals of six months.

Since the fox, dingo and feral dog (domesticated dog gone wild), may also harbour the tapeworm, the control measures outlined above must be advocated with a good deal of reservation. A survey carried out in Victoria some years ago showed that foxes may harbour the adult tapeworms in considerable numbers. Although this survey was confined to a limited number of animals, it indicated the fox to be a natural host of the tapeworm and that foxes may be infected to a much greater extent than are dogs. Support is lent to this view by the fact that the fox frequently kills young lambs, devouring the tongue and muscular tissues. In view of this evidence it has been suggested that the fox may be a much more important factor in the dissemination of C. ovis infection in sheep than is the dog. It is possible in some localities that the dingo and wild dog may play a similar role. If this is the case, the control of the parasite is no longer a practical proceedure and will be effective only to the extent to which the destruction of foxes and similar vermin is possible.

Cysticercus tenuicollis—the thin-necked bladder worm.

Cysticercus tenuicollis occurs principally in the abdominal cavity and is commonly observed at abattoirs, and in sheep killed for ration purposes. The cyst consists of a thin-walled bladder one to two inches in diameter containing clear watery fluid and may be observed hanging from the omentum and mesenteries (abdominal membranes), when the body cavity is opened. The tapeworm head appears as a white opaque spot in the wall of the cyst. Usually not more than three or four cysts are present in an affected sheep. Occasionally, however, as the result of a gross infestation, hundreds of cysts are found scattered throughout the abdominal cavity and at times partially embedded in the liver tissue. In addition to the sheep, C. tenuicollis may be found in cattle, pigs and goats. The parasite is of no importance to human health but is sometimes confused with the Echinococcus or true hydatid cysts, particularly when embedded in the liver.

Cysticercus tenuicollis attached to the omentum of a sheep. (After Clunies Ross and Gardner.)

The adult tapeworm is known as Taenia hydatigena. It is found in the small intestine of the dog where it may attain a length of 16 feet. The life history of the parasite is similar to that described for T. ovis. Upon reaching the liver the embryo leaves the blood vessels and penetrates the liver tissues in which it wanders until it reaches the surface of that organ. It then ruptures the surface of the liver and penetrates the abdominal cavity attaching itself to the abdominal membranes. Here further development takes place finally resulting in the development of the typical bladder-like cyst.

Despite the damage to the liver tissues caused by the migrating embryos, affected sheep suffer no ill effects, the presence of the infection only becoming apparent during examination at the time of slaughter. Since the parasite is of little economic importance and of no importance in relation to human health, the application of measures for its control are rarely warranted. Should such measures be contemplated they would follow the lines described for the control of C. ovis.

Echinococcus granulosis—the Hydatid Cyst.

The Echinococcus or hydatid cyst is found in the lungs and liver but may occasionally occur in other tissues and organs. These cysts vary in size from a quarter of an inch to six inches or more in diameter. The cyst is enclosed in a firm fibrous capsule laid down by the body tissues and is lined by a delicate

Hydatid cysts (Echinococcus granulosus) in liver of sheep.
[U.S. Dept. of Agriculture.]

membrane from which tapeworm heads grow. It is filled with clear watery fluid and contains minute objects resembling grains of sand attached to the cyst wall or floating in the fluid. These are brood capsules each of which contains a number of tapeworm heads. In addition to the sheep hydatid cysts occur in cattle, pigs, other animals and man. In the sheep, which is the natural host of the parasite, the majority of the cysts are fertile, whereas in cattle the cysts are usually sterile containing no living tapeworm heads. About 20 per cent. of the cysts occurring in pigs are also sterile.

The parasite has a wide distribution and is especially prevalent in sheep-raising countries where hydatid cysts commonly occur both in animals and man. In certain areas of Victoria, and New South Wales from 20 to 30 per cent. of sheep and cattle examined have been found to be infected, while in New Zealand an even higher incidence than this has been recorded. The incidence of infection is much lower in Western Australia. At the Midland Junction abattoirs where all animals are subjected to postmortem inspection at the time of slaughter, the records for the years 1943 and 1944 show that less than two per cent. of the sheep examined were infected with hydatid cysts. The figures for cattle and pigs were correspondingly low, being less than .5 per cent. in the former and less than .25 per cent. in the latter.

During the course of meat inspection at abattoirs, organs such as lungs and livers containing hydatid cysts are condemned and subsequently destroyed. Since the cysts do not usually occur elsewhere in the body, condemnation of the carcase is rarely necessary. Infected sheep appear to suffer no ill effects from the presence of the cysts. Even massive infections causing extensive damage to the liver tissues are usually only detected during inspection at the abattoirs.

Life History.

The adult tapeworm occurs in the intestine of the dog and allied species such as the dingo and fox. Unlike the other tapeworms described, it is extremely small rarely exceeding a quarter of an inch in length and containing only two or three segments. On account of its small size and the fact that dogs rarely show any symptoms of the infection, the presence of the parasites is generally overlooked.

The life history of Echinococcus granulosus is similar to that described for T. ovis. Tapeworm eggs voided by infected dogs are swallowed by sheep while grazing and upon reaching the intestine the shell is digested and an embyro is liberated. The embyro penetrates the bowel wall gaining access to the blood vessels by which means it is carried to the liver or lungs where it becomes arrested. Here the embyro continues to grow developing after a period of several months into an Echinococcus or hydatid cyst. Dogs become infected by the consumption of raw offal containing the cysts.

Infection of Man.

The importance of the parasite lies chiefly in its relation to human health; tapeworm cysts located in the liver, less frequently in the lungs and sometimes in the bones causing hydatid disease, a serious and sometimes fatal condition in man. In Western Australia hydatids is not a notifiable disease under the Health Act and consequently the incidence of infection in human beings is unknown. Statistics, however, show that a small number of deaths have occurred annually from the condition.

As in the case of the sheep and other animals, infection in man results from ingestion of tapeworm eggs passed out by infected dogs. The risk of infection is greatest from contact with dogs kept at slaughter houses or on farms and stations where they are able to gain access to raw offal. In cities and large towns where a system of meat inspection exists resulting in the condemnation and destruction of diseased organs, the risks of infection are remote.

The principal risk lies in the handling and fondling of infected dogs. Dogs which are kept on the chain or confined in yards, pass their droppings in the vicinity of the kennels. These eventually disintegrate becoming mixed with the dust. When the dog lies down its coat becomes contaminated by dust containing tapeworm eggs. The risk of infection from the handling of dogs kept under such conditions is apparent, particularly when the precaution of washing the hands is overlooked. The danger is greatest in children who have no knowledge of hygiene. The majority of infections are believed to occur during childhood but these often do not become apparent until adult life.

Other methods of infection include the consumption of raw vegetables such as lettuce contaminated by tapeworm eggs derived from the excretions of dogs, or of water similarly contaminated, but these are considered to be of minor importance.

Prevention of Infection.

Since hydatid disease in man results from the ingestion of tapeworm eggs voided by infected dogs, particular attention should be directed towards the prevention of infection in those animals. Raw offal such as livers, lungs and hearts should never be fed to dogs and provision should be made for the sterilisation of such material by boiling. Boiling for 10 minutes will destroy the parasites. In addition dogs should be regularly treated with arecoline hydrobromide for the removal of tapeworms. Dogs while under treatment, should be chained until purgation has ceased, when the droppings which may contain large numbers of ripe segments and eggs, should be collected and burned. Similarly, dog yards and kennels should be maintained in a clean condition, droppings and bedding being regularly collected and destroyed by burning.

The precaution of washing the hands after handling dogs should never be neglected and this is particularly necessary before partaking of meals. Children require particular supervision in this connection. Young children should not be allowed to play with dogs or in the vicinity of their kennels. Dogs should be excluded from rooms in which food is being prepared or stored. Raw vegetables such as lettuce should be thoroughly washed in running water before use and dogs should be excluded from vegetable gardens. If the drinking water is drawn from a doubtful source it should be boiled before use.

These precautions should be practised in country districts but they should not be necessary in cities and large towns where an efficient system of meat inspection exists.

[Published by Angus and Robertson, and obtainable at all booksellers for 15s.]

"Principles and Methods of Animal Breeding."

By DR. R. B. KELLEY.

SOME ten years ago the United States Department of Agriculture, inspired, no doubt, by the then Secretary for Agriculture, Henry Wallace, published two year-books which were devoted to a survey of animal and plant breeding. The theme of the review devoted to livestock was "Animal Breeding at the Cross-roads." As an epilogue, it may be remarked that during the period 1935-42 egg production per bird in the United States increased more than in the previous 25 years.

The alternatives which the animal breeder has encountered are whether to continue down the broad highway followed in the past, or to deviate in accordance with the results of genetic research. Dr. Kelley presents a closely reasoned and amply documented case for basic changes in outlook, and it is pleasing to find his views being made available by an Australian publisher in a very handsome but moderately priced book.

Dr. Kelley begins by reviewing the work of early English animal breeders, such a Bakewell, and the creation of three famous breeds of livestock. He then traces the methods whereby the modern knowledge of genetic principles was established through the co-ordination of results obtained in widely differing fields.

The closing chapters contain a constructive survey of modern animal breeding methods and those current in Australia. Dr. Kelley is in the fortunate position of being able to draw on first hand knowledge of animal research in U.S.A. and U.S.S.R.

The chapter, Modern Animal Breeding, contains information on the most recent developments in U.S.A. and prewar Denmark, which all emphasise the importance of progeny-testing. The review of Animal Breeding in Australia is very frank, but the criticism is constructive and the author endeavours to show that better methods are not only necessary but within the capacity of the industry.

Before proceeding to a detailed discussion of progeny-testing in fine wool sheep, Dr. Kelley devotes a chapter to artificial insemination which is an important adjunct to improved breeding methods. The fine wool sheep is too important in the Australian economy for its improvement to be anything but the major problem of the industry.

The concluding chapter on Current Research refers, in the main, to investigations of animal husbandry rather than genetics. Reference is made to the local work of Shier and Underwood at the Avondale Research Station on the effect of "flushing" but, no doubt, considerations of space precluded mention of their data on the onset of the breeding season. The factors genetic and environmental which cause ewes to come into oestrus after a non-breeding season are not well established, but Shier and Underwood have shown that there is great uniformity in the date of onset. Dr. Kelley directs attention also to the work being carried out at the University Institute of Agriculture on the relationship of protein intake and wool growth.

Dr. Kelley's book is the first comprehensive Australian publication on animal breeding, and it will be a valuable aid to enlightened animal owners who find themselves at the cross-roads, and to agricultural extension workers. It is not a textbook on genetics and the average reader will benefit from previous reading on heredity as such. Much of the theory of animal genetics rests on rather involved mathematical formula but Dr. Kelley makes the application of modern methods a straight forward, highly interesting and profitable procedure.

A.J.M.

The Resazurin Test for the Determination of Quality in Milk—A Preliminary Trial.

By K. NEEDHAM, Agricultural Adviser.

SYNOPSIS.

The mechanism of the Resazurin test is explained; the method of performing it is outlined, and the advantages of the test compared with those of the Methylene Blue are listed. A brief account of the tests performed at a cheese factory is given.

INTRODUCTION.

THERE have been a number of tests described for the determination of quality in milk in which the use of a dye is employed. One of the most familiar of these, and which is in common use in the dairy industry in this State, is the Methylene Blue Reductase test.

The time required for the Methylene Blue to change from the original blue to white in the sample under observation is recorded and this time is taken as an indication of the quality of the milk in respect to the activity of the bacterial population. A minimum time is prescribed under which the milk must not reduce the Methylene Blue if it is to measure up to the prescribed standards. These times vary but the minimum is usually three hours.

In that section of the dairy industry dealing with whole milk for human consumption, or for cheese milk, there has always been need for some rapid analysis which will give a fairly accurate indication of the bacterial quality of the milk in a short time.

THE MECHANISM OF THE TEST.

The Resazurin test has been developed recently and more nearly approximates the above requirements than the Methylene Blue examination. The principles involved in all dye examinations are based on the fact that the majority of the bacteria during their essential life process have a reducing effect on certain dye stuffs with a resultant change in colour. The degree and rapidity of the reduction varies both with the type and number of organisms present.

The dye Resazurin undergoes two main chemical reactions during its reduction. The first is an irreversible change from blue Resazurin to pink Resorufin and the second is a reversible change from pink Resorufin to colourless Dihydro Resorufin. The two stages cover colours ranging from the initial blue through lilac, mauve, pink and finally to white.

All things being equal it has been found that the colour changes occur in most instances far more rapidly with the dye Resazurin than with Methylene Blue. The advantages of this quicker change are obvious, both from the point of view of the factory and the laboratory. In the case of the factory economy in time of observation is effected and, in the laboratory, time and materials are saved when compared with the more expensive and more protracted plating method.

METHOD OF PERFORMING THE TEST.

The method of performing the Resazurin test is very similar to that used with Methylene Blue. Ten mls. of the sample to be examined are measured into a sterile test tube and one ml. of a 0·005 per cent. solution of Resazurin is added.

The temperature of incubation, 37·5° C., is slightly higher than that used with Methylene Blue (37° C.). The practical difference between the two tests is that, whereas with Methylene Blue examinations observations may be necessary for up to eight hours or even more, with Resazurin the same information can be obtained in one hour. With Resazurin the colour developed at one hour is noted and an indication of quality is obtained. Sterility of technique is observed throughout.

There has been a ten minute Resazurin test suggested, but this does not permit of the finer grading of the milk which is obtained by means of the longer incubation period of one hour.

ADVANTAGES CLAIMED FOR RESAZURIN TEST.

The following advantages have been claimed for the Resazurin test as compared with the Methylene blue test for milk control work.*

1. *Simplicity.*—Only one reading, for example, at one hour is required compared with from six to 12 readings with the Methylene Blue if it extends up to six hours.

2. *Sensitivity to weakly reducing organisms.*—A milk rich in only weakly reducing organisms usually affects Resazurin but may fail to reduce Methylene Blue for many hours.

3. *Sensitivity to cell content (Mastitis).*—A high count of cells whether due to mastitis, colostrum, or late lactation milk, is usually associated with other abnormalities and is disadvantageous for many reasons. Resazurin, but not Methylene Blue, is sensitive to high cell counts in aged milks.

4. *Relation to initial flora.*—In a short time test the result is more likely to bear a closer relation to the initial flora than in a longer test.

5. *Possible contamination in sampling and testing.*—This will naturally be of less significance in a short test.

6. *"Methylene Blue test."*—By prolonging the test to complete reduction it becomes in effect a "Methylene Blue test" of slightly longer time.

LOCAL TRIALS.

Although the Resazurin test has been recognised by the British Ministry of Agriculture and Fisheries as a routine examination, before advocating the use of the test in this State it was considered advisable to carry out some preliminary trials with a view to ascertaining its suitability for application to the industry in Western Australia. This was necessary because of different climatic conditions obtaining and also because of the different set-up in factory routine and facilities for laboratory examination.

It is the practice of the Department of Agriculture to conduct clean milk competitions, and in the course of these competitions, one of the tests used is the Methylene Blue Reductase test. With the co-operation of one of these cheese factories it was possible to arrange to carry out a series of Resazurin trials on duplicate samples which had been subjected to the Methylene Blue examination. Two series of trials were conducted which included 141 samples.

Morning milks were sampled on the receiving platform and duplicate samples taken for Methylene Blue and Resazurin tests. Within an hour of sampling, the Resazurin dye had been added and the tubes were incubated in a water bath, maintained as nearly as possible under factory conditions, to the prescribed 37·5° C.

*Reprint of the article by J. G. Davis of the National Institute for Reearch in Dairying, in Discovery, March, 1943.

Immediately following the introduction of the Resazurin dye, the sample remaining in the sample bottle was smeared for examination later on by means of the microscope.

In Great Britain a series of standard colours have been prepared and these are used preferably in daylight, but, if necessary, with artificial daylight, for comparison with the colours developed in the samples.

By this means the persons performing the test are comparing colours under the same conditions and the element of personal error is largely eliminated. Unfortunately no such colour discs were available at the time of these examinations and it was necessary to confine recordings to the colours observed by the worker using as nearly as possible the same conditions for each sample. Although this method would be entirely unsatisfactory for the general use of the test at different factories it was suitable for the purpose of this preliminary investigation.

In respect to the 141 samples examined, it was possible with Resazurin to obtain information on the bacterial activity of the samples in one hour, compared with up to six hours and longer, in the case of the duplicate samples subjected to Methylene Blue.

In many samples the Methylene Blue was unchanged at six hours whereas the corresponding sample using Resazurin dye showed a considerable reduction, sometimes even to the white stage at one hour. In a few isolated cases the reverse was observed—slight reduction of Resazurin and considerable reduction of Methylene Blue.

The claim that the Resazurin test is more sensitive to the presence of cells was not fully borne out in the trials. In some instances this was found to be the case while other samples, apparently of high quality on the basis of colour, later showed a very high cell content on direct microscopic examination, and, in one instance, a condition typical of contagious streptococcic mastitis was present. The necessity for regular microscopic checks following dye tests is obvious. It is possible, however, that the lack of sensitivity of the Resazurin to cell content in these examinations was due to the comparative freshness of the milk on examination. In the majority of samples subjected to the Resazurin test in Great Britain, milk is held, according to whether it is a morning or evening sample, up to 24 hours before examination. After a period of holding the activity of the cells is considerably increased compared with the freshly drawn sample.

The technique of performing the test and the various aspects which must be considered in the interpretation of the results have not been discussed in detail in this article. It is hoped when certain equipment now on order is available that it will be possible to conduct further investigations in accordance with the standards prescribed by the British Ministry of Agriculture and Fisheries and to evolve a modified technique which will be suitable for local conditions.

CONCLUSION.

The information obtained so far permits of two main deductions:—

1. That the Resazurin test as claimed is considerably faster than the Methylene Blue test and gives in a shorter time at least the same amount of information and in many cases more.
2. That the Resazurin test like the Methylene Blue test should be followed up at fairly frequent intervals by direct microscopic examination.

ACKNOWLEDGMENT.

The author desires to acknowledge the assistance rendered Mr. N. McKeown, Agricultural Adviser, Mr. V. Weston, Dairy Instructor, and the staff of The South-West Co-operative Dairy Farmers Ltd., Harvey, in the course of these observations.

The Babcock Test for the Estimation of Butterfat in Milk and Cream.

A. H. HOBBS, Dairy Branch.

INTRODUCTION.

FROM time to time inquiries are received from dairy farmers, and others, for details of the technique of the Babcock Test. An endeavour is made in the following article to describe in simple form the various steps in the manipulation of the test while, at the same time, drawing the attention of the beginner to the difficulties which may be encountered, and the necessary precautions to be observed, in order to obtain accurate and satisfactory results.

The Babcock Test was invented by Dr. Babcock, an American scientist, in 1890. It was originally designed for the estimation of the butterfat content of milk, but has since been modified and can be used for milk, cream, skim milk, buttermilk, etc. For practical factory and farm fat determinations, it is now used almost exclusively in the United States of America and Australasia.

It is the test generally used as a basis for payment for milk and cream and, in addition, enables producers to detect unprofitable cows, thus furnishing a valuable guide to herd improvement. It has also aided in the detection of fraud caused by the watering or skimming of milk.

Dr. Babcock based his test on the fact that strong sulphuric acid will break down the "solids not fat" of milk and thus enable the fat to separate out. To effect a speedy and complete separation of the fat the flasks holding the mixture of milk and acid are placed in a centrifugal machine, or so-called "tester," and whirled at high speed. Hot water is then added to bring the liquid fat into the graduated neck of the test flasks and, after repeated whirling, the length of the fat column is measured, showing the percentage of fat contained in the sample tested.

DIRECTIONS FOR TESTING MILK.

Apparatus required:—

- Sample bottles.
- 17.6 c.c. pipette for measuring milk.
- 17.5 c.c. acid measure.
- Sulphuric acid (specific gravity 1.82-1.83).
- Milk test flasks (graduated 0-10).
- Centrifuge (or tester).
- Dividers.
- Dairy thermometer.
- Water bath.

Sampling.

The milk to be tested is first mixed by pouring from one vessel to another two or three times so that the butterfat will be evenly distributed throughout the bulk. The sample is then dipped out immediately and placed in a sample bottle.

Before measuring out the quantity to be tested, the milk in the sample bottle is further mixed by shaking the bottle vigorously. The shaking should not be so violent as to cause undue foaming. The reason for sampling immediately after mixing is that the butterfat is the lightest constituent of the milk and it will commence to rise to the surface within a few minutes if the milk is allowed to stand. Hence the sample taken would not be representative of the bulk.

The measuring pipette, which has a capacity of 17.6 cubic centimetres, is filled with milk by sucking the milk into it until this rises a little above the 17.6 c.c. mark; the forefinger is then quickly placed over the top end of the pipette before the milk runs down. By slightly releasing the pressure of the finger, the milk is now allowed to run down until it reaches the mark. The finger should be moist but not wet, so that the milk may be readily checked by gentle pressure. The point of the pipette is now placed in the neck of the Babcock test flask, and the milk is allowed to flow slowly down the inside of the neck, care being taken that none is lost in the transfer. The last of the milk in the pipette is gently blown into the test flask.

Actually the amount of milk delivered by the pipette is 17.5 cubic centimetres, the difference, .1 c.c., being an allowance made for the small quantity which adheres to the walls.

The temperature of the milk at the time of sampling should be 65-70°F.

The accuracy of the test depends on the fact that the sample taken weighs 18 grams, and 17.5 c.c. of milk at its average specific gravity of 1.032 will be found to weigh this amount.

Adding the Acid.

17.5 c.c. of sulphuric acid, the temperature of which should be 65-70°F., is measured by means of the acid measure. This amount of acid is carefully poured into the test bottle containing the milk. In performing this operation, the test bottle is conveniently held at an angle, so that the acid will run down the wall of the bottle, and not run in a small stream into the centre of the milk. The bottle is slowly rotated during the adding of the acid, thus clearing the neck of adhering milk.

If the acid is poured into the middle of the milk, charring of the fat may occur, and there is also the danger of completely filling the neck with acid, in which case the expansion of air in the bottle may force the acid out on to the operator's hands.

The milk and acid in the test flask should be in two distinct layers. A black band of partially mixed liquid may appear between the layers, but this should be only slight. Such a dark layer often results in an indistinct fat column in the final reading. The appearance of black flocculant matter in or below the fat column renders a correct measurement difficult, if not impossible.

After adding, the acid is carefully mixed with the milk by holding the test bottle by the neck at an angle and giving it a rotary motion. In doing this, care should be taken that the liquid is not shaken into the neck, and when once the mixing has begun, it should be continued until completed. The mixture becomes hot by the action of the acid on the water in the milk and turns a dark chocolate colour. Its temperature will now be about 180°F. Violent mixing may cause charring of the fat, whilst insufficient mixing may produce curd in the fat column.

Note.—Sulphuric acid has a great affinity for water and will weaken, through the absorption of moisture from the atmosphere, if not kept in air-tight containers. It is very corrosive, hence stoppers for bottles should be of glass, earthenware, or rubber. It should be handled with care and, if spilt on the skin, should be washed off immediately with plenty of cold water. If spilt on the clothes, they should be washed as above and then treated with dilute ammonia solution.

Whirling the Tests.

The test flasks containing the mixture of acid and milk are placed in the centrifuge immediately mixing is completed, care being taken that they are placed in such a position that the machine is balanced correctly so that it will run without vibration.

Oil the machine before starting and increase the speed gradually. The correct speed is usually indicated on the crank of hand operated machines but, if not, it may be calculated from the diameter of the disc which carries the cups. The diameter is measured from the bottom of one cup, through the centre of the disc to the bottom of the opposite cup with both cups held in a horizontal position. The following speeds for discs of various size create the correct centrifugal force of 30 lb. per square inch inside the test flasks:—

Diameter of Disc.	Revs. per minute.
10in.	1074
12in.	980
14in.	909
16in.	848
18in.	800
20in.	759
22in.	724
24in.	693

To find the speed of the handle, give the handle one full turn slowly, and note the number of revolutions of the disc. This figure is then divided into the revolutions desired, according to the size of the disc, and the answer will represent the number of turns per minute of the handle.

Correct speed is important, as low speeds give low readings. Slightly excessive speed is not harmful, but increases the pressure in the bottles and may cause breakages.

It is not absolutely necessary to whirl the test bottles in the centrifuge as soon as the milk and acid are mixed, but this method is much to be preferred. They may, however, be left for any reasonable time up to 24 hours without the test being spoiled; but if left until the mixture becomes cold, the bottles must be placed in hot water (about 160°F.) for fifteen minutes before whirling.

The first whirling of the test bottles is carried out for five minutes. This will bring all the fat to the surface of the liquid.

Adding the Water.

Hot water (temperature 160-180°F.) is now added by means of a pipette, or some special device, to fill the bottle to the base of the neck. The bottles are whirled again at full speed for two minutes and hot water as above is added a second time until the lower part of the fat column comes within the scale on the neck of the bottle, preferably about the 1 or 2% mark, so as to allow for the sinking of the fat column due to the gradual cooling of the contents of the bottle. This second filling of water should be allowed to fall directly on to the fat, to assist in the removal of any undissolved matter.

The bottles are now whirled a third time for one minute. This completes the test.

The above whirling times should be taken from the time the machine reaches the correct speed.

Measuring the Fat.

The correct temperature for reading the fat column is 140°F. This is important for the reason that temperatures 10-15° lower than this give low readings owing to contraction of the fat, and vice versa; also this temperature ensures that the fat column will have a sharply defined upper and lower meniscus. If several tests have been done in a hand operated machine, they should be placed in the water bath at 140°F. with the water depth equal to the height of the fat column and allowed to remain there for three minutes before commencing to read.

The water between the fat column and the mixture in the test bottle should be clear. If milky, this indicates that too little, too weak, or too cold acid has been used, and the solids not fat are not thoroughly dissolved. If black flocculant substances are present, the indication is that too much, too strong, or too hot acid has been used, or that mixing has been too violent.

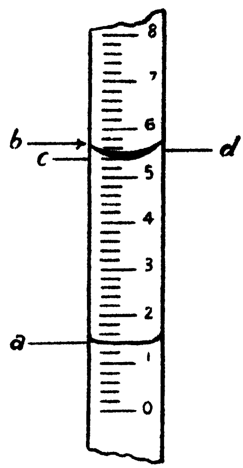


Fig 1—Correct method of reading the milk test. Read from a to b

The fat column is measured from the bottom of the column to the extreme top of the meniscus as illustrated in Fig. 1. This operation is simplified by the use of the dividers, by placing one point on the bottom of the column and the other on the top of the meniscus; then the dividers are moved, without altering the distance between the points, so that the bottom point rests on the 0 mark on the scale, and the upper point gives the reading in per cent. of fat. The space between each two large divisions on the scale equals 1%, and that between each two of the smaller divisions equals two-tenths or .2%. If the fat column illustrated in Fig. 1 is examined, it will be found that the bottom of the column is on the second small graduation above the 1, and the top of the meniscus is mid-way between the third and fourth small graduations above the 5. Therefore, the per cent. of fat in this instance is 5.7 minus 1.4 = 4.3%

The reason for reading to the top of the meniscus is that it has been found by making a comparison between a large number of tests and the gravimetric analysis of the same samples, that an allowance has to be made for a small number of minute fat globules which, owing to their size, are not extracted from the mixture during whirling.

The relation between the amount of milk taken and the capacity of the graduated portion of the neck of the milk flask is as under:—

The amount of milk taken is 18 grams (17.5 c.c.). The neck of the flask is

graduated 0 to 10, and the capacity of this graduated portion is 2 c.c. Since the specific gravity of butterfat at 140°F. is .9, the weight of 2 c.c. of butterfat is 2 x .9 = 1.8 grams, and 1.8 grams is one-tenth or 10% of 18 grams. Therefore, the graduated portion of the neck, when full of butterfat, at 140°F., would represent 10% of the sample taken, and the small divisions 1% and .2%, respectively.

The quantity of butterfat contained in a definite amount of milk is calculated by means of the following formula:—

$$\frac{\text{Weight of milk in lb.} \times \text{Test}}{100} = \text{lb. of fat.}$$

Hence, if a cow produces in 24 hours, 36 lb. of milk with an average test of 4.3%, the butter fat contained in this milk will be—

$$\frac{36 \times 4.3}{100} = 1.548 \text{ lb. fat.}$$

COMPOSITE SAMPLING OF MILK.

Where large numbers of different lots of milk are recorded daily, *e.g.*, the milk supply to cheese factories, or in testing herds for production, a great saving in time, labour and material is obtained by the use of composite samples.

A composite sample is a mixture of samples of various deliveries of milk from the same source, taken over a period of time, usually not more than seven days.

To ensure that a composite sample is a true representation of the milk to which it refers, it is essential that each small sample should bear a definite relation to the quantity of milk from which it was obtained.

Example.

A cow gives 20 lb. of milk in the evening and 30 lb. in the morning. To obtain an accurate mixed sample from this cow it would be necessary to take from the morning's milk one and one half times the amount taken from the evening's milk. If using a two ounce sample bottle, it is convenient in calculating the amount of the sample to be taken from the night's milk to use a definite number of c.c. per pound of milk produced, to bring the night sample as close as possible to 20 c.c. Then it will be found that the quantity of milk produced by the cow the following morning will give a sample which will be contained comfortably in the two ounce bottle. Hence, in the above example, it would be necessary to take 1 c.c. per lb. of milk produced and the quantity of the evening and morning samples would be 20 c.c. and 30 c.c., respectively. If the cow gives 7 lb. in the evening, it will be necessary to take 3 c.c. per lb. of milk and the sample will be 7 x 3 = 21 c.c.; if the following morning she gives 9 lb., the quantity of the morning sample will be 9 x 3 = 27 c.c., making the total of the composite sample 21 plus 27 = 48 c.c.

In taking composite samples of daily supplies to factories of mixed herd milk, it may be found that the quantity delivered daily by each supplier will vary by only a few pounds, and, if this is so, the same quantity sample may be taken each day. If, however, any great variation occurs, it is necessary that the quantity of the sample should vary accordingly.

Composite samples are prevented from curdling by the addition to the first small sample taken of a few drops of Formalin (40% solution of formaldehyde in water). This, however, has the effect of decreasing the solubility of the solids not fat, which may result in a curdy fat column in the finished test. Consequently, as little formalin as possible should be used, depending on the size of the sample and

the length of time it has to be kept. One drop of formalin, placed in the samples of evening milk for the purpose of herd recording, is sufficient to keep the milk sweet over night in hot weather.

Formalin is a poison, and should always be labelled as such.

Sample bottles should always be scrupulously clean and are most conveniently cleaned immediately after emptying.

THE BABCOCK TEST FOR CREAM.

Cream may be tested by the Babcock method in a somewhat similar manner as for milk. The results are accurate when the necessary care has been taken in sampling the cream and measuring the fat.

The composition of cream varies greatly according to the operation of separators, temperature and composition of milk, etc.; the fat content of supplies delivered to butter factories in this country usually ranges from 30 to 50 per cent. Because of this wide variation, and for other reasons mentioned below, the measuring of cream for the Babcock test is inaccurate, and correct results can therefore only be obtained by weighing the sample to be tested.

The specific gravity of cream is lower than that of milk, and varies according to its butterfat content; *e.g.*, the more fat the cream contains, the less a certain quantity of it will weigh.

Cream is more viscous than milk, and more of it will adhere to the sides of the pipette, especially in the case of very thick cream; also, in the case of freshly separated cream, air will be present incorporated during the separating process. With ripened cream fermentation gases developed are held in the cream. Hence, in either of the latter two cases, the weight of a certain measure is diminished. Fig. 2 shows the height to which creams of varying fat content must be raised in the pipette to get the same weight of each.

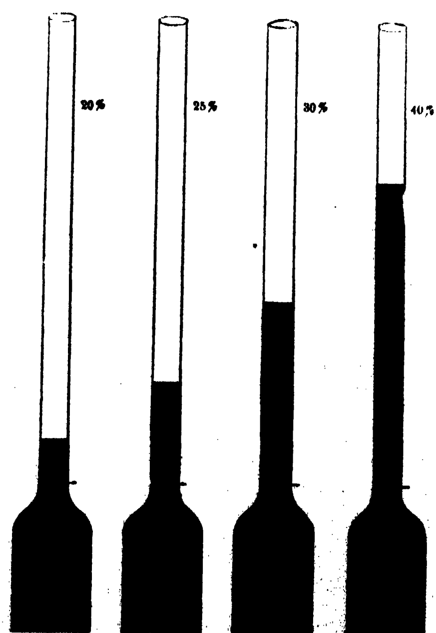


Fig. 2.

The Dairy Industry Act in force in Western Australia provides that "the butter fat content of cream purchased for the manufacture of butter shall be estimated by the Babcock method and that the samples to be tested shall be weighed with an approved scale." The technique of the cream test is as for milk, except that a 9-gram sample is taken in place of the 18 grams used in the milk test, and as the basis of the Babcock test is an 18-gram sample, and the graduations on the neck of the bottle are calculated on this basis, the final butterfat reading is doubled.

Apparatus.

The apparatus used in the cream test is as for milk, substituting cream flasks graduated 0-30 in place of the milk flasks, and using a special cream balance for weighing the samples.

Sampling.

The cream to be sampled should be well stirred to ensure an even distribution of the butter fat. This is facilitated by the use of a metal stirrer having a mushroom end which will ensure thorough mixing. In taking the sample, it is the practice in butter factories in this State to use a "thief" sampler. This is constructed on the principle of a syringe and cuts a core of cream right through the contents of the can. This core is then readily transferred to the sample bottle by pressure on the plunger.

Weighing the Samples for Testing.

The special cream balance should be set up on a firm bench, and levelled by means of the adjusting screws. This balance is a delicate mechanism, and should be kept clean and bright, with the knife edges working freely to ensure accuracy. The cream test flasks are then placed in the balance trays and the scale is balanced by adjusting the small weight provided on the beam.

The samples should be heated to a temperature of 100-120°F. by placing them in warm water; this is done to ensure ease of weighing.

When the cream is thoroughly liquified, the first sample is shaken vigorously, and having first placed a 9 gram weight on one of the balance trays, the sample is immediately transferred by means of a pipette from the sample bottle to one of the cream flasks on the opposite side of the scale. The beam of the balance is now brought to rest on the supports, the 9 gram weight is removed from the tray and the second sample is balanced against the first. Each tray on the balance holds six flasks and the above procedure is repeated until all 12 samples have been weighed. In this manner, the sample numbers will be arranged with the odd numbers on one tray and the even numbers on the other and, as most factories are equipped with steam turbine centrifuges holding 36 flasks, it is customary to weigh and test the samples in batches of this number. After weighing, the samples are arranged in trays holding 36 flasks and approximately 9 c.c. of warm water is added to each flask and mixed with the cream. The mixing may be done by shaking all flasks together in the tray.

Adding the Acid.

Fifteen to 17.5 c.c. of acid is used. The amount depends on the quantity of fat in the cream, and can only be determined by observation. The colour of the mixture is the best guide, coffee brown being correct, light brown not sufficient, and black indicating too much acid used. Samples appearing too light in colour after mixing can be corrected by the addition of a little more acid and further mixing.

Owing to the "solids not fat" content of cream being lower than that of milk, the colour of the mixture will appear light at first, and it is advisable not to whirl at once after mixing but to allow the bottles to stand for five to 10 minutes until the colour change is complete.

The flasks may now be placed in the centrifuge and the procedure from this point is similar to the milk test until the stage of reading the fat column is reached.

Alternative Method.

A modification of the preceding method is given below and is preferred by some operators for the reason that where large numbers of tests are carried out daily, a considerable saving in quantity of acid and time is achieved.

Some experience is necessary, however, with this method to enable clear fat columns to be obtained regularly.

1. Weigh 9 grams cream.
2. Add 9 c.c. sulphuric acid. Mix and allow to act.
3. Add 7-9 c.c. of hot water.
4. Whirl five minutes.
5. Add hot water to top of neck.
6. Whirl one minute.
7. Place in water bath.
8. Read.

Where steam turbine centrifuges are used, errors due to expansion of the fat may occur if the centrifuge is allowed to get too hot. Very hot tests should be cooled to 140°F. for at least three minutes before reading to obtain correct results. Conversely, using hand operated centrifuges in cold weather, tests should be placed in hot water (temperature 180°F.) for a few minutes in between whirlings, and then placed in the water bath (temperature 140°F.) for three minutes prior to reading.

Reading the Cream Tests.

Fig. 3 shows the correct method of reading the fat column in cream tests, the reading being taken from the bottom of the fat column to the *bottom* of the meniscus. This reading is doubled to give the percentage of fat.

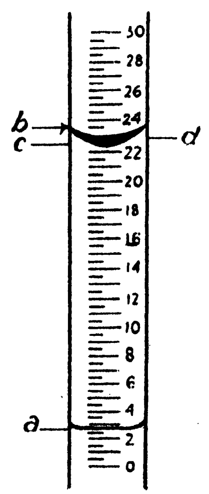


Fig. 3.—Correct method of reading the cream test. Read from a to c.

Other precautions to be observed for the correct measurement of the fat column are the same as in the milk test.

If the cream test illustrated in Fig. 3 is examined, it will be found that the bottom of the fat column is on the 2.5 mark and the bottom of the meniscus is on the 22.5 mark.

$22.5 - 2.5 = 20$

$20 \times 2 = 40\%$ of butterfat in the sample tested.

Relation between the quantity of cream *taken and the graduated portion of the neck of the* 18 *gram* 30% *cream flask.*

Capacity of the graduated portion	=	6 c.c.
30 graduations, each one	=	.2 c.c.
Specific gravity of butterfat at 140°F.	=	.9

Therefore, weight of fat in each division = .2 x .9 = .18 grams; .18 grams = 1% of 18 grams.

As the weight of the sample used is 9 grams, the reading must be doubled.

Eliminating the Meniscus in Cream Tests.

The meniscus in cream tests may be eliminated by the use of coloured glymol. Glymol is a white oil, lighter than butterfat, usually coloured red with Alkanet root. When added to the cream flask it levels off the top of the fat column giving a straight line at the top as well as the bottom, thus removing any doubt as to the point at which the reading should be taken.

Glymol should be added carefully by means of a pipette and allowed to run gently down the inside of the neck of the flask. If it falls directly into the fat column, it will sink into the liquid fat and, on rising, will carry some of the fat on its surface, thus decreasing somewhat the length of the fat column and giving low readings. Reading should be done immediately the glymol is added. If left, the colouring matter will combine with the surface fat, making accurate reading difficult.

The quantity of butter fat contained in a definite amount of cream is calculated as follows:—

$$\frac{\text{Weight of cream in lb.} \times \text{test}}{100} = \text{lb. of fat.}$$

Hence a can containing 48 lb. of cream testing 43% would contain—

$$\frac{48 \times 43}{100} = 20.64 \text{ lb. of fat.}$$

THE BABCOCK TEST FOR SKIM MILK AND BUTTERMILK.

As mentioned previously, the Babcock test was designed originally for the estimation of fat in milk and such milk products as cream. For this purpose it is reliable. When used for testing the industry's by-products (skim milk and buttermilk) the results have been found to be considerably below those obtained by gravimetric analysis, *i.e.*, extraction with ether and weighing the fat. Early attempts at testing skim milk and buttermilk were made by using the ordinary 10% 18 gram milk test flask, but these were found to be of no value for the reason that the fat appeared merely as a few dots in the neck of the flask, and could not be measured accurately.

Later the double-bore skim milk flask (illustrated in Fig. 4) was designed, and proved very convenient for the purpose. Its use has been adopted in all countries where the Babcock test is favoured. These flasks are graduated 0-25, the space between each two marks representing .01%, and the total graduated portion .25%.

The construction of these flasks for use in Britain, as laid down by the British Standards Institution, provides for the graduated portion of the neck to contain 50 divisions, each one representing .01% and the total .5%.

The American Association of Creamery Butter Manufacturers during its study of losses of fat in buttermilk devised a test for the accurate determination of fat in buttermilk which has since been adopted as suitable also for skim milk.

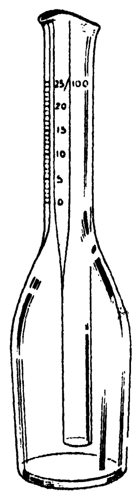


Fig. 4.—Double Bore Skim Milk Flask.

The American Association Test.

This method of estimating the percentage of fat in skim milk and buttermilk makes use of a small amount of normal butyl alcohol in addition to the sulphuric acid, to promote a more ready separation of the fat from the mixture in the test flask.

Normal butyl alcohol is free from impurities and, being quite stable, is not likely to be attacked by the sulphuric acid. It does not possess a pungent or offensive odour or flavour and is more pleasant to use than other alcohols.

Directions for Making the Test.

Apparatus.

Double-bore skim milk flasks.
9 c.c. pipette for milk.
2 c.c. pipette for n-butyl alcohol.
Other apparatus is as for testing whole milk.

Place 2 c.c. n-butyl alcohol in the test flask and to this add 9 c.c. of the well-mixed buttermilk or skim milk to be tested. The temperature at sampling should be 65-70°F. Add 7-9 c.c. sulphuric acid, varying the amount to obtain a resultant fat column golden yellow in colour.

The contents of the flask are then mixed thoroughly, the flask is placed in the centrifuge and whirled at full speed for six minutes. Hot water is then added to fill the flask almost to the base of the neck, and a further whirling of two minutes is given. More hot water is added to float the fat into the graduated neck, and the flask again whirled for two minutes.

The reading is done at a temperature of 130-140°F., and the result is doubled to give the percentage of fat.

When the double-bore flask is used, it should be placed in the centrifuge with the large filling tube to the centre, so that all the fat will gather freely in the calibrated neck.

In performing the Babcock test on any milk product it is important that the water used for floating the fat into the neck of the flasks should be of a soft nature. Foam appearing on the surface of the fat column makes accurate reading difficult and is caused by the action of the acid on impurities (usually carbonates) in hard water.

If soft water cannot be obtained, the boiling of hard water will often correct the trouble, due to the fact that most of the carbonates which cause foaming will be precipitated.

Dingo Trapping and Poisoning.

A. G. MOORE, Trapper, Department of Agriculture.

Foreword by A. Arnold, Chief Inspector, Vermin Department.

THE following article on the trapping and poisoning of dingoes should be read in conjunction and compared with the methods given in the Department's Bulletin No. 438 on Vermin Poisoning. It will be noted that Mr. Moore's methods differ in some details from those given in Bulletin 438, but such differences need not be given undue importance. The Department has a dozen good trappers and probably each one's methods differ slightly from the others.

Mr. Moore is a very successful trapper, and at the same time is a keen and successful poisoner of wild dogs; the capacity of excelling in both methods is not always found in the one person, as many trappers concentrate on trapping and tend to neglect the equally, if not more, important side of this work. This article, therefore, is of the greater value, and I particularly wish to draw the reader's notice to his emphasis on "smell" or rather *the absence of it;* note for instance his injunction not to spit or drop cigarette butts, etc., anywhere near the set.

A wild dog, especially one which has had some contact with man and his works, is intensely suspicious and his nose is his chief means of putting him on guard against his enemy No. 1. If anyone doubts the keenness of a dog's nose, let him remember how a domestic dog can trail his owner along bitumen roads and pavements where hundreds of other feet have trod, and then reflect that a wild dog's nose is likely to be even more keen.

ADJUSTING AND POISONING TRAPS.

The adjustment of traps is essential to avoid catching small animals such as rabbits, cats, opossums, etc. The centre of the plate should take 3 lb. weight before being sprung. This allows of the dingo's weight, and balance, to be placed

on the trap before springing it and conduces to a good "high" catch, and gives the dog no chance of springing away in time to avoid the jaws as he will do if he feels the plate giving before his weight is well placed on that foot.

This ability of the plate to carry weight is obtained by filing the tongue to a clean flat edge and by filing the under side of the catch at a slight upward angle, thus making a claw grip of the catch and tongue.

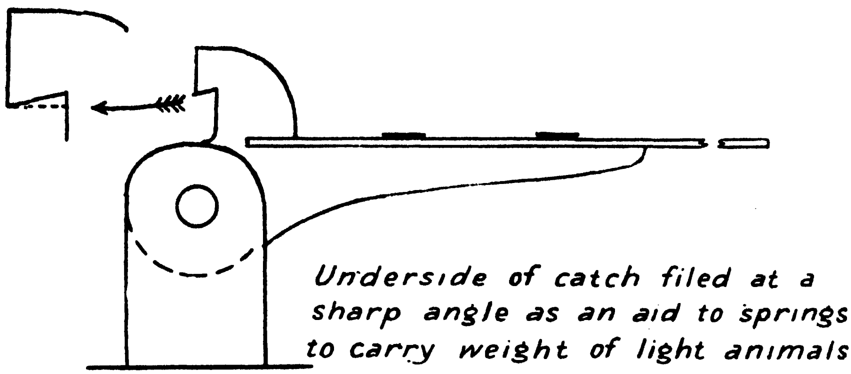


Fig 1.—Showing method of filing catch.

The catch must be filed to allow the outer edge of the plate to drop only half an inch before the trap is sprung.

Traps which are poisoned should not be staked or tied down, such staking, etc., merely increases the chance of leaving the human scent and this should be avoided. Every trap should be well-poisoned before setting; proceed as follows:—

Take a piece of brown paper 6 in. x 8 in. and double it down the centre. Put a quantity of strychnine along the centre crease after the style of making a cigarette, then roll in the same manner. Fold the two ends of this, roll back and lay the roll on the top side of the jaw, which is held down by the tongue of the trap, keeping the folded ends between the roll and the jaw and tie thereto with fine wire.

This method leaves little or no smell, is simple, clean and economical in strychnine. Any kind of strychnine, powdered or crystal, can be used. When a catch has been made, any strychnine left in the roll can be used again in a new roll. Traps must be thoroughtly cleaned and repoisoned after each catch.

Places to Set Traps.

The best places to set traps are along the dingoes' beats when travelling to water, to hunt, or to the paddocks to kill, at bushes and trees where they scratch, and along creek beds, old roads and pads. Place your decoy in the most suitable places on the windward side of your "set." An effective decoy is some dog or dingo manure set about 15 inches back from the front jaw of the trap as indicated by the guide stick just in front of the trap. (To bring his nose to the decoy, the average dog must place his foot fair on the plate.)

Setting the Trap.

In setting traps it should be remembered that in almost every district wild dogs have been "educated" by faulty traps and faulty methods of trapping, and the would-be trapper must see to it that every trap must be in good condition, well

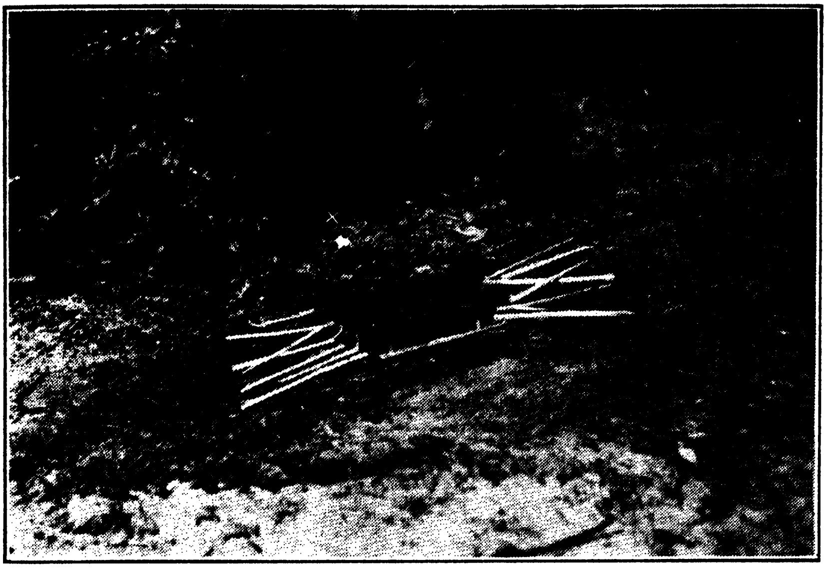


Fig. 2.—Twigs placed on sides of location of trap to prevent dog from approaching from side; straight twig in front of trap and against pegs to ensure dog stepping over it on to plate of trap.

poisoned and most effectively set. The cunning (or educated) dog is constantly on the alert, and his ability to detect smell not natural to the place is his greatest protection; therefore the trap must be set with the least possible foreign smell.

Fig. 3.—Trap finally covered with leaves and debris so that surface appears natural. X's show pegs against which guide stick is placed.

Use a bag to stand or kneel on whilst setting the trap, and to place the earth from the trap hole on. Place the trap on the ground in the exact position it is to occupy and mark the four points with the tomahawk. Lift away the trap and drag the tomahawk from point to point, marking the shape of the trap. Then chop the ground loose, and lift out and place the soil on the bag, using a flat sided tin about 2 in. by 3 in. by about 3½ in. long for this purpose. The trap hole should be of a depth so that the plate of the set trap will be half an inch below the surface level.

Holes can be punched in the tin for sieving the soil when covering the trap, particularly in gravelly country. Stand the trap "end on" on the ground and push down the spring with the hands, allowing the clip to slip down on the spring, then repeat with the other end. The jaws can now be opened easily. Hold the plate firmly, and gently tap the tongue forward with the tomahawk to make sure the catch and tongue are properly engaged.

Now place the trap in the hole with the "free" jaw facing the dog's approach and the poisoned jaw nearest the decoy, and slip the safety clips back along the springs with the thumbs. Lift up the free jaw (the one nearest you) and place a piece of wood the length of the jaw beneath it so that when resting firmly on the wood the jaw comes level with the plate. This allows the soil to pack firmly around the jaws and accelerates the speed of the trap by having only one jaw in contact with the springs to start off with.

Place the earth firmly around the jaws and springs, using the tin and being careful not to use the hands. Place two small pegs in the ground half an inch out from the corners of the jaw nearest you (see Fig. 3); these act later as trap position marks, and also keep the guide stick from being knocked on to the trap. Place eight little sticks or blackboy tops about as thick as a match and three inches long across from the jaws and springs to the plate of the trap. These support the paper and prevent small animals from breaking through the paper during wet weather. (Fig. 4.)

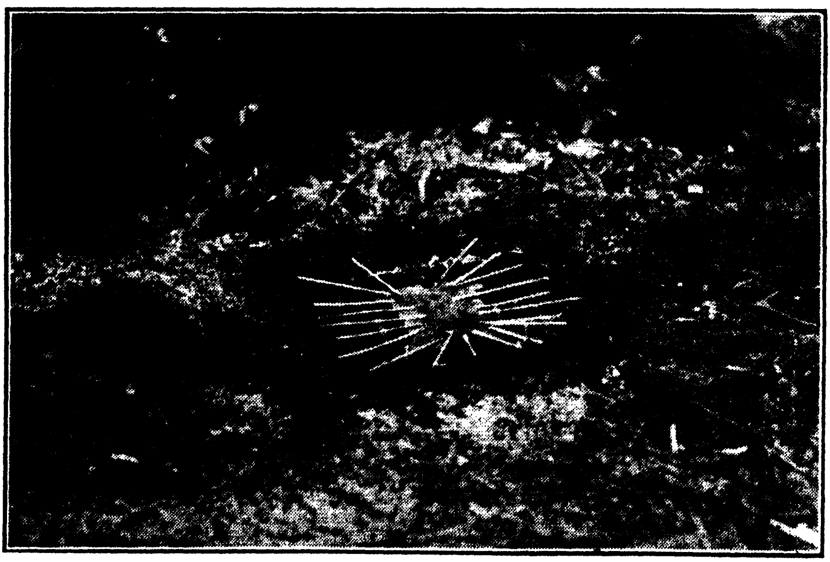


Fig. 4.—Trap prepared with twigs to carry weight of paper with covering soil.

Use a single sheet of paper about $8\frac{1}{2}$ in. by 9 in. for a 7 in. trap. The single sheet keeps the smell down better than two pieces.

Some of the earth is now sieved on to the paper and the weight of it takes the paper down flat on to the plate and gives a clear patch. Put the earth on evenly with the tin, using the side of the tin to pack the earth firmly over the paper and springs. This prevents rain from washing the paper bare, keeps down any smell on the trap and prevents the dog from feeling the trap with his feet.

For final covering, use fine pieces of broken leaves which wash around bunches of grass, or washed surface sand, in sandy country; old ant nest material may also be used. Lay the guide stick in front of the two little pegs in front of the trap. (See Fig. 2.) Use a stick about half an inch thick and 12 inches in length.

Some end pieces of scrub or fine ends of limbs can be stood up in the ground on each side of the trap, forward as far as the guide stick, as natural as possible, and a few further back, just leaving an entrance over the guide stick and trap to the decoy.

Take the bag and the remainder of the earth removed from the trap hole some distance away before tipping it out and take care during the setting of the trap not to walk about more than necessary, or to spit about or drop cigarette butts, pieces of paper, etc.

In some districts kangaroos are troublesome as they will eat dog manure for the minerals. Take carefully prepared bath water of a dog, not using soap or hands, and sprinkle the trap and decoy. Dog or dingo's feet wash is best as a dog sweats at the feet. The doggy smell keeps the kangaroos away and makes a good dingo decoy also. A paint brush can be used for the purpose of sprinkling the ground with the wash water.

Traps should be left at least three days in summer and five days in winter before inspection. (Natives can often be shown how to set traps, and, in fact, they do so and camouflage them perhaps better than the white man. However, they will usually visit them the next day to see results, their gins will visit them the following day and their picaninnies the subsequent day; the result being that the human odour is so strong that dogs will not come near the traps.) When setting traps without decoy on pads or old roads, set them just the same as with decoy, but always set them lengthways in the pad; the plate value is much greater and the jaws close in from the sides of the pad, making it impossible for the trap to be sprung without making a catch. After setting, place a guide stick across the pad two inches from the jaws of the trap. The pad can be narrowed in by standing some dry pieces of scrub in the ground, but do not use limbs with dry leaves on. Do not set traps crossways in pads or old roads. This is an old practice and is undoubtedly responsible for so many wild dogs being educated and difficult to trap, and I cannot stress this point too strongly.

The method advocated in this article has been worked out and tested over many months' experimenting, using a dingo kept for the purpose, and tried out in every way in order to evolve a thorough and successful method of trapping wild dogs.

DESTROYING DINGO PUPS.

Pups are found in many different places, usually within a mile of fresh water. The most likely places are outcrops of rocks, dens, bulrush swamps, paperbark lakes, creeks, rivers and at times, on the plains in bunches of scrub or mallee.

When small pups are found it is very simple to catch the mother. Put the pups in a bag, tie the mouth and leave them in the den; (always pick up the pups by the back of the neck). Place the traps at the entrance or approaches to the den. The bagged pups will make plenty of noise and the mother will make a big effort to reach them, regardless of smell, and is caught.

If the pups are too big when found, and run away, set your traps some distance away on leads to the den, such as creek beds, old roads, pads, etc. When the mother is caught the pups can be destroyed by poison baits and by poisoning any meat the mother has left for them about the den, or can be shot or trapped.

Sometimes two or three families will unite, making anything up to 15 pups in the one den. If the pups are small enough to handle, just leave three pups bagged in the den, one from each litter; these can be fed each day with sugar and water and bits of meat until all the mothers are caught. In such cases it is advisable to set traps on leads at a distance from the den as well as on the near approaches to the pups.

MAKING OF BAITS FOR POISONING DINGOES.

Suet Baits.

The bait recommended is the small suet bait. It stands the sun and weather well, and is not often taken by ants. Cut the suet into a pot or billy-can and place over a hot open fire for about 30 seconds. This gives the baits a burnt or "crackling" smell which is most attractive to and liked by dingoes.

Mash or mix the hot suet to a paste and when cool enough, cut into small pieces about the size of the first joint of the thumb, or as round as a shilling piece; place each bait on a piece of paper about 2½ in. square (apple wrapping paper preferred), flatten the suet and place in the centre sufficient strychnine to lightly cover a 3d. piece, or to cover ¼ in. of the small blade of a pocket knife heaped up. Then squeeze up and roll between the thumb and first two fingers, keeping the poison in the centre of the bait.

The small *Blood Bait* is made in the same way. When the suet is brought to a paste as above, add ½ lb. of fresh blood to 2 lbs. of suet and stir in sufficient pollard (about two-thirds of a cupful to above quantities). These baits can be placed into apple wrapping paper or into longer pieces of brown paper and unwrapped before being laid. These baits dry hard, keep well and give good results. Always place baits in the shade if at all possible.

For *Meat Baits*, the legs of rabbits, dried through being hung up for a few days, make good baits, and you thus utilise one class of vermin in order to destroy another.

Where to Lay Baits.

Lay poisoned baits along beats, leads, creeks, rivers and at springs, dams, lakes and swamps; also on their breeding grounds, hunting grounds, on pads, old roads, at road junctions, fence corners and wherever dogs scratch or camp.

Flax and Linseed Breeding in W.A.

WADA, A NEW RUST RESISTANT FLAX VARIETY.

I. THOMAS, Superintendent of Wheat Farming.
A. J. MILLINGTON, Plant Geneticist.

PLANT breeders in Australia have been concerned chiefly with the development of new varieties of Old World crops suited to local conditions. The future of wheat in Australia was most unpromising in the 70's of the last century, but the development of varieties much earlier maturing than the English and South African types then available completely altered the economics of the industry. The earlier maturing varieties made possible the cultivation of wheat in the drier interior, where land was freely available in extensive areas and rust was seldom a problem. In Western Australia in particular our agriculture is almost entirely dependent on introduced plants which arrived either fortuitously or by design, and specific strains have been developed for local conditions in crops as diverse as wheat, oats, potatoes, runner beans, carrots and sub-clover.

LINSEED CULTIVATION IN W.A.

When attempts were made during the war years to establish flax and linseed as commercial crops in W.A., no varieties specifically bred for W.A. conditions were available. The linseed variety Punjab, an Indian type grown extensively under irrigation in California was introduced and cultivated for seed production. Because of susceptibility to a local rust race and the relatively late maturity which made the seed bolls very subject to cutworm attack, the production of Punjab proved uneconomical and the attempt to establish linseed growing as an industry in W.A. failed. The growth made by Punjab in the absence of rust and cutworms indicated that yields at least as high as those obtained under dry land conditions in most other linseed growing countries should be obtained when a variety suited to local conditions was available. The development of such a variety is being undertaken at the Avondale Research Station, and several very early maturing and rust resistant strains are being increased for commercial testing. Although it is unlikely that even the earliest maturing linseeds will escape damage from cutworms in every season, they are much less liable to attack (Table 1). Promising results have also been obtained by Jenkins (1945) with the new insecticides such as D.D.T., which are very economical in use.

Table 1.—Avondale Research Station, 1944.

Variety.	Maturity.	% Bolls Damaged.
Riga Crown	Very Early.	25
Italian	Early.	43
Walsh*	Midseason.	70

* Walsh is of much the same maturity as Punjab.

The linseed breeding programme has been materially assisted by the New South Wales Department of Agriculture making available its large collection of varieties and crossbreds.

FLAX BREEDING.

Since flax and linseed are varieties of one plant species developed for fibre and seed production respectively, they are subject to attack by the same diseases and pests. Rust and cutworms have added materially to the cost of producing flax in this State and the prospects of the industry are to a large extent related to the development of satisfactory controls for them.

Cass Smith and Millington (1944) in a review of wheat rust, state that it over-summers almost entirely on volunteer plants and grasses and consequently seldom reaches epidemic form in W.A. unless there is considerable summer or early autumn rain. Earlier work by Cass Smith (1942) showed that flax rust carries over in much greater quantity because most infected straw is capable of causing infection in the subsequent season. As the terminal branchlets of the plant are usually the most severely attacked (Fig. 1) the seed yield is markedly reduced in even moderate rust epidemics. It is generally considered that straw quality is reduced by the presence of rust. Elsewhere in this Journal is a review of the rust races in W.A. by the Plant Pathologist, Mr. W. P. Cass Smith.

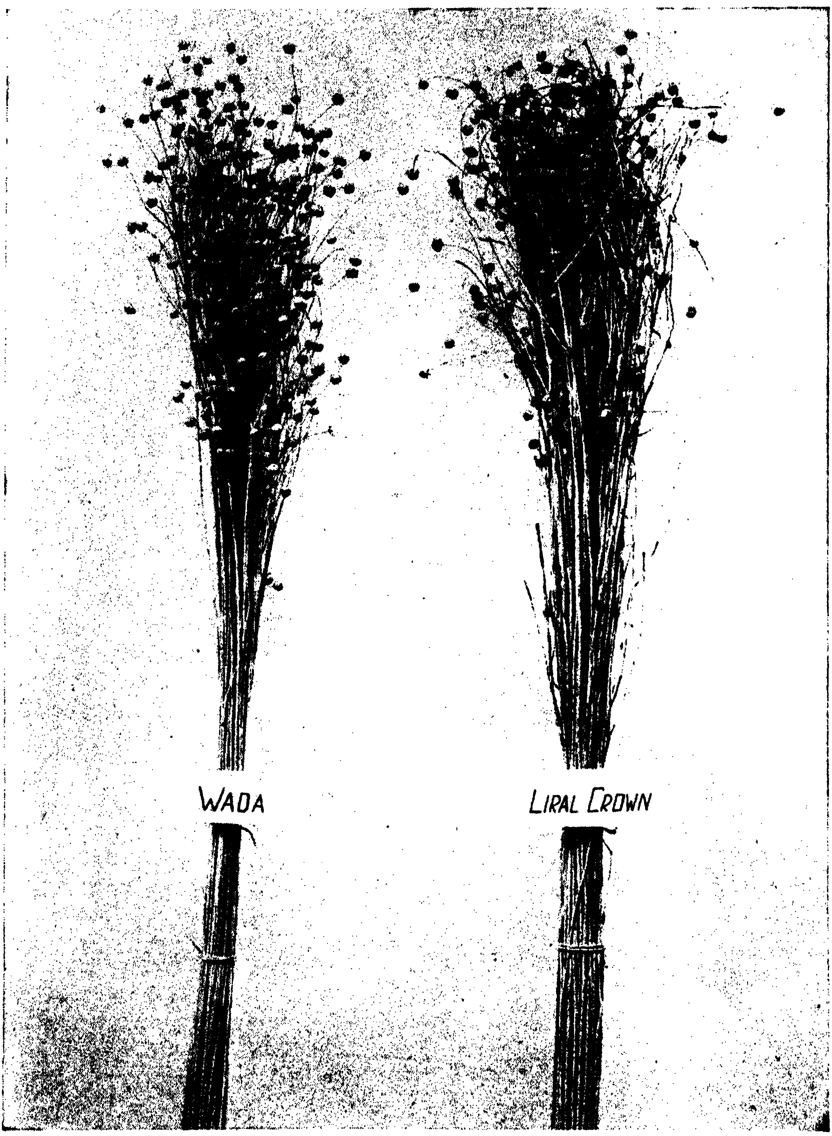


Fig. 1.—The rust infection is heaviest on the terminal branchlets, many of which on Liral Crown have broken off. It can be seen that there are no rust pustules on Wada.

Elliott has stated (1944) that cutworms have materially reduced the seed yields of flax crops and in severe epidemics have eaten the straw at the site of the rust pustules.

Flax Cross-breeding.

A number of the available linseeds are immune to rust in Australia and crosses between these and the commercial flaxes will give resistant flax type progeny. This approach is being actively undertaken in several States, and the programme includes repeatedly back-crossing the resistant crossbred progeny to the flax parent and retaining the resistant plants. The end product of such a programme is a variety identical with the flax parent except in respect to rust resistance.

Selection from Varieties.

Most flax varieties comprise a mixture of types, since they have not been pure lined as has been the case with the popular cereal varieties.

The possibility of their containing rust resistant types was therefore investigated by raising a large collection of varieties in the rust liable districts. The variety Riga Crown which originated in the Baltic States was found to contain a small percentage of rust resistant plants. These have served as a basis for the variety Wada, bred by one of the authors of this article, A. J. Millington, which it is hoped will be released for commercial increase during 1946.

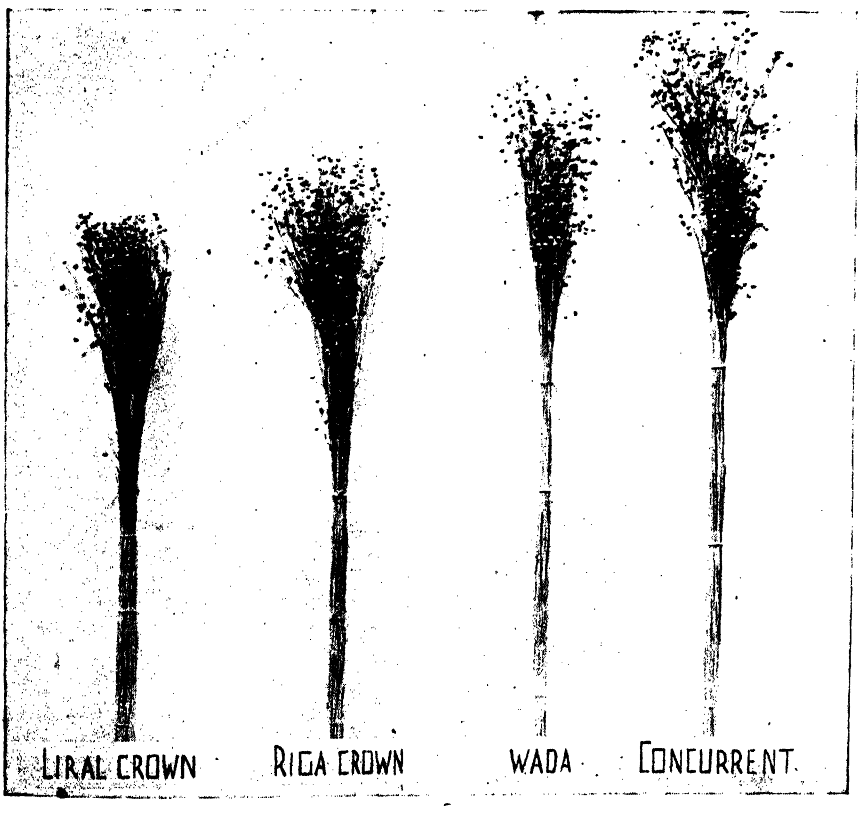


Fig. 2.—Wada is usually taller than Liral Crown and Riga Crown but is shorter than Concurrent.

Wada is an early maturing variety similar in growth habit and appearance to Liral Crown, but usually slightly taller growing as will be seen from Fig. 2. The earlier maturity and immunity to rust will make it less subject than Concurrent to cutworm damage.

Rust resistant selections have been developed from crosses between Wada and Concurrent for testing against the former variety for yield and fibre quality.

Fibre Quality.

Although the farmer is concerned more directly with fibre quantity and yield of straw per acre, considerations of quality may determine the extent of the industry in the future.

Fibre quality is very difficult to define and is dependent on a number of environmental factors such as soil type, season, rate of seeding, time of planting and harvesting, etc., besides variety. From the viewpoint of plant breeding, it is therefore essential to have some appreciation of the influence of these factors on both the fibre quality and the variety. These factors are being actively investigated by the Agrostological Section of the Dairy Branch.

ACKNOWLEDGMENT.

Appreciation is acknowledged of the assistance of Officers of the Dairy, Plant Pathology and Entomological Branches in defining the objectives of the flax and linseed breeding programme, whilst the trials of the new variety conducted and reported on by Messrs. H. K. Gibsone, H. G. Elliott, W. P. Cass Smith and H. L. Harvey have been most valuable. Thanks are also due to Dr I. A. Watson of Sydney University for his seedling resistance tests. These have served to confirm our knowledge of the resistance of the new variety. The breeding of rust resistant flax varieties has been actively sponsored by the Flax Production Committee which has convened a conference of flax breeders each year.

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Flax Rust in Western Australia.

W. P. CASS SMITH, Plant Pathologist.
H. L. HARVEY, Assistant Plant Pathologist.

FLAX rust is caused by a fungus *Melampsore lini,* and it occurs in all parts of the world where flax is cultivated. The disease was first recorded in Western Australia in 1931, but it was of no economic importance here until the recent World War, when flax was first cultivated commercially. During the war years, increased production of flax for fibre became an urgent matter and a considerable area was soon planted. The cultivation of linseed was also attempted during the same period.

Experience soon showed that flax rust was a disease to be reckoned with for yearly since the 1941 season, it has proved a major limiting factor to economic crop production, and therefore to the permanent establishment of a peace-time industry.

Linseed crops of the Punjab variety grown in the Avon Valley districts have been so severely damaged by flax rust, that the disease has been largely responsible for the temporary failure to establish the industry here.

On the fibre varieties, the damage has not been so serious. Nevertheless, losses varying from slight to total crop failure have been noticed. In 1942 the disease was responsible for an estimated reduction of 20 per cent. in straw yields, plus a 10 per cent. reduction in straw values over an area of approximately 8,000 acres (1). Experience throughout the world has shown that once flax rust becomes widespread, it can only be controlled satisfactorily by the use of resistant varieties and, fostered by the Commonwealth Flax Production Committee, investigations have been carried out both in Western Australia and in other States of the Commonwealth with this end in view.

RACES OF FLAX RUST—THEIR IDENTIFICATION AND DISTRIBUTION.

The breeding of resistant varieties is complicated by the fact that the flax rust fungus is a highly specialised parasite which comprises a number of races. These races vary in their ability to attack different fibre or linseed varieties, and so a variety which is immune to one race of the fungus may be very susceptible to another race.

To complicate matters further, the distribution of the rust races is not uniform in all localities. (See page 44.) For example, in the Boyup Brook area, the centre of the fibre flax belt, the fibre variety Concurrent becomes heavily rusted when conditions are favourable for disease development. However, in the Northam area where linseed varieties only have been cultivated, it has been grown in small plots without a trace of rust. This does not mean that Concurrent is rust resistant in the Northam area; it merely indicates that a rust race which attacks it is not yet present or not sufficiently widespread in that locality. Were Concurrent widely grown in the Northam area, there is little doubt that sooner or later it would develop rust owing to the spread of races to which it is susceptible. It follows, therefore, that a variety cannot be regarded as rust resistant until it has been tested against all races of the fungus occurring here.

The continued collection, and accurate identification, of rust races is, therefore, an important corollary to the breeding of resistant varieties.

In Australia, the onerous work of identifying the races of flax rust has been carried out by Dr. W. L. Waterhouse and Dr. I. A. Watson of Sydney University (2). Rust collections forwarded from the various States are grown on seedlings of a standard set of "differential" flax and linseed varieties in the glasshouse and the reactions to the disease are noted. If two samples of flax rust collected in different localities produce exactly the same reactions on the "differential" varieties, the component races are regarded as identical. If the reactions differ on one or more varieties, however, different races are involved. By comparing the reactions produced by a newly collected rust sample with those previously recorded from other localities, the rust can be identified as either a new or a known race.

After identification, every endeavour is made to propogate the various races permanently, so that they will be available for testing the resistance of new selections or crossbred material.

In 1941 when commercial flax cultivation was first undertaken here, little was known of the distribution of flax rust or the number of component races in Western Australia.

From rust collections forwarded—in the making of which many colleagues have assisted—six races of the fungus have now been identified from W.A. (3) (4), whereas ten races have been tentatively determined for Australia and New Zealand. The local rust races were collected from either commercial varieties or "wild flax'' and these, together with the localities in which they were obtained are as follows:—

RACE A—Boyup Brook, Northam, Merredin, Beverley, Avondale, West Wagin, Woodman's Point, Wagin, Narrogin, Brookton Road, Bremer Bay, Kojonup, Wongan Hills, Toompup, Yarloop, East Bremer Bay.

RACE B—Boyup Brook.

RACE C—Boyup Brook, Roelands.

RACE D—Boyup Brook.

RACE E—Boyup Brook, Yarloop, Scott's Brook, Cookernup, Pinjarra, Mayanup, Mumballup, Kulikup, Donnybrook, Beelerup, Wokalup, Muradup.

RACE G—West Bremer Bay.

Race A is typically a rust of linseed varieties, such as Punjab, and it caused severe damage to this variety when grown commercially in the Avon Valley districts.

Races B. C. D and E attack the fibre varieties such as Concurrent and Liral Crown and of these Race E is the most virulent.

Race G, which has so far only been recorded in this State from West Bremer Bay, resmbles Race A in that it is mainly a rust of linseed varieties.

WILD FLAX IN RELATION TO THE DISEASE.

In addition to attacking cultivated flax varieties, the flax rust parasite also attacks certain "wild flax'' species. Two "wild flaxes'' occur here namely, *Linum marginale* and *L. gallicum*. The former is a native perennial plant which is widely distributed, whereas the latter is an introduced annual of limited occurrence. In South-eastern Australia, *L. marginale* has long been known as a host of flax rust but in Western Australia the disease had not been recorded on this host, when commercial flax cultivation was first undertaken during the war years.

Because of its wide distribution and perennial habit, it was thought that *L. marginale* might play an important part in harbouring the fungus from year to year and spreading the disease to commercial crops. "Wild flax'' surveys were, therefore, undertaken in conjunction with the Government Botanist, Mr. C. A. Gardner, as a result of which an even wider distribution of the species was discovered (5), (6).

Specimens affected with rust were discovered in a number of localities and, from these, three races have been identified, namely, races A, E, and G. Of these, Race A appears to be most widely distributed on "wild flax," having been found at Woodman's Point, Wagin, West Wagin, Narrogin, Brookton Road, Bremer Bay, Kojonup. Race E has been found at Scott's Brook and Race G at West Bremer Bay.

It is also of interest to note that "wild flax'' was found occurring most abundantly in the Boyup Brook and adjacent districts, and that here four out of the five known rust races have been recorded, the greatest number in any locality. In addition to harbouring rust, therefore, it appears likely that *L. marginale* may play an important part in the production of new races, by natural crossing.

Unlike *L. marginale,* the annual *L. gallicum* appears to be immune to local rust races for no rusted specimens have as yet been discovered in this State.

RUST INDICATOR PLOTS.

To facilitate the discovery of new races, and to investigate more fully the distribution of those already recorded, the planting of "rust indicator" plots in numerous localities was commenced in 1943, and is still being continued each season.

At each site, a similar group of flax and linseed varieties is planted, including commercial varieties, some of the "differential" set used in the glasshouse for race-determination, together with others of interest to the plant breeder.

The sites chosen are not confined to the commercial fibre flax and linseed growing areas, but they include other localities far removed, where "wild flax" is known to exist.

In all but a few plots, rust has developed each year, at least on certain varieties, allowing valuable rust collections to be made. The use of "rust indicator" plots has simplified the detection and collection of rust in "wild flax" areas, for owing to its sporadic occurrence *L. marginale* is difficult to locate and therefore rusted specimens may easily escape notice.

Information of interest from the plant breeding aspect has also been obtained from this work, for certain varieties including Ottawa 770B and Argentine Selection (C.I. No. 462) have shown immunity at all sites. Others including Uruguay 36/48 have shown high resistance throughout, while immune variants were noted in a number of other varieties.

The performance of immune or resistant varieties such as these is watched with interest from year to year, for any departure from the normal rust reaction will indicate the appearance of a new race.

It is also of interest to note that the new variety Wada* showed freedom from rust at all sites last season, a result which helps to confirm the resistance of this variety as indicated by glasshouse tests at Sydney Unversity.

Acknowledgment.

Grateful acknowledgment is made of the help received from Messrs. H. K. Gibsone, H. G. Elliott, A. J. Millington and other colleagues who have assisted with rust collections and in other ways. Thanks are also given to Messrs. F. C. West of Toompup, G. Baty of Bremer Bay, E. Doncon of Grass Valley, and T. Eastcott of Boyup Brook School, and others who have rendered invaluable assistance in connection with the planting of "rust indicator" plots.

* See article in this issue by I. Thomas and A. J. Millington, "Wada, a New Rust Resistant Flax Variety."

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Wheat Variety Trials on the Research Stations.

I. THOMAS, Superintendent of Wheat Farming.

A. J. MILLINGTON, Plant Geneticist.

WHEAT Variety Trials were conducted at the five wheatbelt Research Stations and in each instance two plantings were made, one of mid-season varieties sown during the first fortnight in May, and one of early or very early varieties planted towards the end of that month. The two leading varieties in the State in their respective maturity classes, Bencubbin and Bungulla, were used as controls.

Yields, except at the Merredin and Salmon Gums Research Stations, were rather low and in general the later plantings yielded rather better than the earlier ones.

Bencubbin and Bungulla remain the most prolific varieties under test, although, at the Salmon Gums Research Station, the crossbred W.19 has equalled the former variety in each of the last two years. Because of its low yield at the other Stations it is not proposed to release W.19 as a variety.

Of the four rust resistant varieties, Charter, Eureka, M.60 and M.62 under test, the best yields have been recorded by the first mentioned. In view of their relatively low yields and indifferent flour strength it is proposed to discard the crossbreds M.60 and M.62.

THE SEASON.

The season was characterised generally by a rather late opening which was followed by, in some instances, the wettest June on record. July rainfall was in most instances below average, whilst August was exceptionally wet. There was an absence of finishing rains but crops generally yielded better than was anticipated.

VARIETAL NOTES.

Very Early Maturing Varieties.

Bungulla.—The acreage sown to this variety has increased very rapidly and it is now the third leading wheat in Western Australia. It is the most prolific early, or very early, variety under test, but for most satisfactory results it should not be planted before the fourth week in May or the first week in June. Bungulla is resistant to Flag Smut but susceptible to rust, although it tends, because of its early maturity, to escape the latter disease.

Charter.—This variety was released in 1944 by the New South Wales Department of Agriculture and was derived from a cross between Kenya and Gular. It is a tall growing variety which has proved satisfactory for hay. The grain is normally very hard and translucent, with less tendency to mottle than is the case with Eureka. The grain of Charter frequently yields flour of premium strength. Unlike Eureka which is susceptible to the new rust strain which has appeared in New South Wales, Charter is resistant to all Australian rusts. It is the most prolific of the rust resistant varieties at present under test, but the yields generally are below those obtained from Bungulla.

Early Variety.

Koorda.—The most satisfactory yields have been obtained with this variety on the light land at Wongan Hills Research Station, where its excellent straw strength makes for ease of harvesting. Koorda is almost immune to Flag Smut but susceptible to rust.

WHEATBELT RESEARCH STATION RAINFALL.

Research Station.	Period.	Jan.	Feb.	Mar.	April.	Growing Period.							Nov.	Dec.	Annual Total.
						May.	June.	July.	Aug.	Sept.	Oct.	Total.			
Avondale ...	1945 ...	...	1	134	43	188	1,083	193	528	127	7	2,126	86	10	2,400
	Average ...	26	40	111	79	221	327	299	252	107	80	1,287	46	34	1,622
Chapman ...	1945 ...	...	29	25	15	283	939	233	381	149	19	2,004	33	27	2,133
	Average ...	28	39	68	72	233	427	384	267	148	85	1,547	35	27	1,815
Merredin ...	1945 ...	...	2	105	31	107	431	90	305	83	8	1,024	7	26	1,195
	Average ...	45	57	98	88	137	192	179	154	81	74	818	40	60	1,206
Salmon Gums	1945 ...	10	6	29	93	59	346	100	112	123	3	743	22	140	1,043
	Average ...	91	71	149	92	130	149	142	152	90	111	774	88	84	1,348
Wongan Hills	1945 ...	...	41	69	71	165	629	214	416	124	14	1,562	48	30	1,821
	Average ...	36	49	100	87	189	263	252	207	95	69	1,075	41	45	1,432

WHEAT VARIETY TRIALS.
1945

LATE SOWN SECTION

Variety.	Maturity relative to Koorda.	Rust Reaction.	Avondale Research Station. 1945 Yield.	Avondale Per cent. Control. 1945.	Avondale Per cent. Control. 1944–5.	Chapman Research Station. 1945 Yield.	Chapman Per cent. Control. 1945.	Chapman Per cent. Control. 1944–5.	Merredin Research Station. 1945 Yield.	Merredin Per cent. Control. 1945.	Merredin Per cent. Control. 1944–5.	Salmon Gums Research Station. 1945 Yield.	Salmon Gums Per cent. Control. 1945.	Salmon Gums Per cent. Control. 1944–5.	Wongan Hills Research Station. 1945 Yield.	Wongan Hills Per cent. Control. 1945.	Wongan Hills Per cent. Control. 1944–5.
			bus. lb.			bus. lb.			bus. lb.			bus. lb.			bus. lb.		
Bungulla	— 7	Susceptible	17 52	100	100	10 32	100	100	27 42	100	100	20 54	100	100	16 29	100	100
Charter	— 6	Resistant	14 8	75	....	11 27	109	97	25 6	91	88	18 14	87	....	11 50	72	71
Koorda	=	Susceptible	15 17	86	86	10 47	102	85	21 42	78	78	20 58	100	88	12 16	74	84
M.60	=	Resistant	17 9	96	89	11 35	110	91	23 50	86	82	18 34	89	84	14 56	91	86
M.62	=	Resistant	13 25	75	....	10 5	96	91	21 20	77	....	17 20	83	80	12 26	75	77
Diff. for Significence (P + ·05)			....	....	....	....	....	....	32	2	....	1 12	6	....	1 16	7	....

EARLY SOWN SECTION

Variety.	Maturity relative to Koorda.	Rust Reaction.	Avondale 1945 Yield.	Avondale 1945.	Avondale 1944–5.	Chapman 1945 Yield.	Chapman 1945.	Chapman 1944–5.	Merredin 1945 Yield.	Merredin 1945.	Merredin 1944–5.	Salmon Gums 1945 Yield.	Salmon Gums 1945.	Salmon Gums 1944–5.	Wongan Hills 1945 Yield.	Wongan Hills 1945.	Wongan Hills 1944–5.
Bencubbin	+ 8	Susceptible	9 36	100	100	9 42	100	100	25 28	100	100	21 4	100	100	6 58	100	....
Eureka	+ 6	Resistant	10 45	112	84	10 45	111	77	21 57	86	80	19 47	94	84	5 26	78	....
Kondut	+10	Moderately Susceptible	9 41	100	90	10 59	113	90	18 22	72	67	19 22	92	83	5 14	75	....
W.19	+10	Moderately Susceptible	9 9	95	92	8 43	90	78	....	....	....	21 17	101	99	5 15	75	....
M.60	=	Resistant	....	....	....	....	....	....	21 52	86	....	....	....	....	....	....	....
M.62	=	Resistant	....	....	....	....	....	....	21 15	83	....	....	....	....	....	....	....
Diff. for Significence (P = ·05)			....	....	....	1 2	10	....	2 12	9	....	1 17	6	....	1 24	20	....

Mid-season Varieties.

Bencubbin.—This remains the most extensively grown variety in Western Australia, and it has given more satisfactory yields than any other mid-season variety under test. Bencubbin is resistant to Flag Smut but susceptible to rust.

Kondut.—On the whole, yields obtained from this variety are less than those of Bencubbin, but this may, in part be due to its slightly later maturity. The straw strength of Kondut is excellent and it frequently yields flour which is above the f.a.q. for the State, in respect to strength. Kondut is resistant to Flag Smut, and appears to be less susceptible to rust than Bencubbin.

Eureka.—The yields obtained from Eureka have been, on the whole, rather disappointing, particularly under conditions of low rainfall or low soil fertility. The grain is normally translucent, but it frequently mottles badly. In all tests in Western Australia, Eureka has proved resistant to rust, but in New South Wales it is very susceptible to a new strain which has appeared. The straw strength of Eureka is very satisfactory, and it also possesses resistance to Flag Smut.

ACKNOWLEDGMENTS.

The authors gratefully acknowledge the assistance of the farm managers in conducting the trials and supplying the yield data.

Avondale Research Station—Mr. W. A. Human.

Chapman Research Station—Mr. W. Coxon.

Merredin Research Station—F. Gishubl.

Salmon Gums Research Station—J. Tudor.

Wongan Hills Research Station—D. R. Bateman.

Thanks are due also to the Conservator of Forests, Mr. T. N. Stoate, for the statistical analysis of the results.

Superphosphate Rationing in Western Australia

1941-42 to 1945-46.

By L. J. H. TEAKLE and D. J. COLLINS.

AUSTRALIA normally obtains supplies of phosphatic rock for the manufacture of superphosphate from Nauru and Ocean Islands, in the Pacific Ocean. On these islands is an estimated 150 million tons of the highest grade phosphatic rock in the world. From this can be manufactured superphosphate of excellent quality with a guaranteed phosphoric acid (P_2O_5) content of 23 per cent. A 24 per cent. grade can be obtained by selection of the phosphatic rock.

With the uncertainty of supplies arising out of the war conditions in 1939, the Commonwealth Government arranged for a 12 months' reserve of rock phosphate to be built up in the Commonwealth. All of the business with relation to the supply and handling of the phosphate supplies for Australia was left in the hands of the British Phosphate Commission and the Department of Commerce and Agriculture. The farmers of Australia are indebted to the efficient service which these authorities, acting through the Phosphate Committee, have rendered to them during the difficult war period.

The first actual break in supplies resulted from the damage caused when installations on Nauru Island were shelled by a German raider on 27th December, 1940. The interference with the handling of phosphatic rock at Nauru, combined with other difficulties, led to restriction in supplies and the Commonwealth Government decided that it would be necessary to reduce the allocation to farmers throughout the Commonwealth in 1941-42. In this year, no formal rationing scheme was devised, but farmers were restricted to 60 per cent. of their normal usage, as indicated by their purchases in 1939-40.

Japan's entry into the war on 7th December, 1941, resulted in the loss of Nauru, Ocean, and Christmas Islands in the Pacific Ocean. This aggravated the shortage of phosphatic rock, and necessitated the formulation of a systematic scheme of rationing throughout the Commonwealth under National Security Regulations. Arrangements were made to obtain supplies of phosphatic rock from Egypt and the British Phosphate Commission explored all possible sources for Australian supplies. Small tonnages of local rock were utilised in South Australia and Western Australia. Unfortunately the local and Egyptian phosphatic rocks were of poor quality, and even by mixing with a certain amount of the reserves of high-grade rock from Nauru and Ocean Islands, it was not possible to maintain a guaranteed phosphoric acid content above 18 per cent. P_2O_5. In some instances it was necessary to drop the guarantee to 17 per cent. P_2O_5.

Besides being of low phosphoric acid content, the Egyptian rock proved unpleasant to handle, and its high salt content resulted in the formation of hydrochloric acid in the production of superphosphate and manufacturers and farmers have been faced with a severe problem due to the rotting of bags. The setting of the product when treated with ground limestone to reduce the damage to the bags, caused by the hydrochloric acid, has constituted another difficulty.

During the rationing period, the quota of superphosphate in Australia from year to year was dependent on the availability of shipping and the supply position in Egypt, and the amount allocated was decided by Allied policy. Each year the Department of Commerce and Agriculture presented a case for the supply of superphosphate and pressed the claims of Australia for this important fertiliser as the basis of food production in the Allied war effort. The year 1939-40 was adopted as the base year throughout Australia and allocations were made to the States by the Department of Commerce and Agriculture on a scale determined by the Agricultural Council. The scale was in the ratio determined by the tonnage purchased by the States and used for the various crop categories in the base year.

Under National Security Regulations, the permanent head of each State Department was given the authority to ration fertilisers and the responsibility for devising a rationing scheme for the respective States and the determination of the quota available to each farmer. No fixed Commonwealth-wide method for fertiliser rationing within the States was decided, but each State authority was free to devise a scheme adaptable to local conditions, to ensure that each farmer would receive an equitable quota.

The quantity of superphosphate available for Australia in 1942-43 was 480,000 tons, which is 50 per cent. of that sold in the base year—1939-40. For Western Australia, the quota in 1942-43 was 119,700 tons, as compared with 264,500 tons in 1939-40. Western Australia's share in the Australian quota was only 45.2 per cent. of the 1939-40 usage, owing to the effect of reservations for priority crops in Western Australia being lower than the average for other States.

QUANTITY OF SUPERPHOSPHATE AVAILABLE.

The quantity of superphosphate available for the Commonwealth and for Western Australia in each year since the war began, is given in Table I.

TABLE I.

Year.	Commonwealth.	Western Australia.
1939–40	960,000	264,690
1940–41	920,000	245,807
1941–42	672,000	177,200
1942–43	480,000	119,700
1943–44	520,000	121,404
1944–45	800,000	195,755
1945–46	1,140,000	265,818

RATIONING OF SUPERPHOSPHATE IN WESTERN AUSTRALIA.

For rationing purposes, crops were divided into three categories:

1. Priority crops: These were of particular importance in Australia's part in the war effort.
2. Orchards and vineyards.
3. Non-priority, or general farming, crops.

In order to illustrate the distribution of superphosphate among these categories, the figures for 1942-43 may be cited:

		Tons (estimated).
1.	Priority crops	12,200
2.	Orchards and Vineyards	1,180
3.	Other crops	96,000
	Contingencies	10,320
		119,700

SUPERPHOSPHATE RATIONING MACHINERY.

Throughout Australia it was decided that priority crops should receive their normal dressings, which would be the first call on Australian stocks. In consequence, those States growing a considerable acreage of priority crops received a larger share of the Australian quota than the others. After deducting the estimated requirements for priority crops, the remaining superphosphate was distributed pro rata among the States, on the basis of the sales for the non-priority crops in 1939-40. For 1942-43, the Western Australian share was 26.36 per cent. of the Australian quota for non-priority crops.

In Western Australia, the following principles underlie the machinery used in superphosphate rationing:

1. The fertiliser available should be utilised not only to return the maximum of the various agricultural products but also that those products required for war purposes should receive utmost consideration. This amounted to an extension of the Commonwealth principle of priority crops.

2. That the great economic importance of wheat production in Western Australia should be borne in mind.

3. The complication introduced in Western Australia by reason of the compulsory reduction in wheat acreage, with compensation, together with the considerable reduction in acreage of a voluntary nature, and the States undertaking to limit the wheat crop to a harvest of 22 million bushels, be taken into account.

4. On the basis of experiments, indicating that under normal seasonal conditions, crops in the higher rainfall areas would show a greater relative depression in yield, owing to reduced supplies of superphosphate, adjustment according to rainfall is justified.

5. That provided wheat growing was confined to—

   (a) the heavier types of soils most suitable for wheat growing; and

   (b) old land which has been well cultivated and has received liberal applications of superphosphate in the past,

   it could be expected that at least a 90 per cent. crop would result in a normal season, should the superphosphate application be reduced to 40 lbs. per acre.

On the basis of the above principles, the superphosphate requirements of other crops were fully examined, and a rate of superphosphate per acre allotted, to effect full utilisation of the total quota for the State. To give effect to this, farmers were requested to supply the Department of Agriculture with particulars regarding their cropping programmes, in order that their ration of superphosphate could be decided.

The details for 1942-43 may be taken to illustrate the method used in computing quotas for farmers in Western Australia under superphosphate rationing. For priority crops on the Commonwealth list, Table II. indicates the estimated acreage involved and the ration of superphosphate allowed:

TABLE II.

Crop.	Estimated Area.	Superphosphate Ration Rate per Acre.
	acres.	cwts.
Potatoes	7,000	15
Vegetables	8,000	15
Vegetable Seeds	40	15
Blue Boiler Peas	2,000	2
Navy Beans	100	3
Berry Fruits	50	4
Flax...	9,000	2
Tobacco	1,700	10

It was estimated that these crops would require 12,200 tons of superphosphate.

In subsequent years, a measure of priority was accorded crops and pastures for dairying. In 1943-44, dairy farmers were allowed 126 lbs. of superphosphate for each 100 lbs. of butter fat delivered at a factory, or 250 gallons of whole milk supplied. This supplement was increased from 126 lbs. to 150 lbs. in 1944-45 and 1945-46.

For orchards and vineyards, the rates per acre allocated have varied from year to year, as shown in Table III.

TABLE III.

Variety.	1942–43.	1943–44.	1944–45.	1945–46.
	cwt.	cwt.	cwt.	cwt.
Citrus	2·0	2·0	3·0	3·0
Dried Vine Fruits ...	1·5	1·5	2·25	3·0
Wine and Fresh Grapes ...	1·0	1·0	1·5	3·0
All others	1·0	1·0	1·5	3·0

The allocation for non-priority crops for 1942-43 represented only 40 per cent. of normal usage. This occasioned a severe cut in the superphosphate available and allocations were made according to the schedule in Table IV.

TABLE IV.

Crop.	Acres (Estimated).	Dressing per acre under Scheme.	Estimated Tonnage Utilised.
		cwt.	
Irrigated—			
Pastures	9,500	2	950
Fodder	5,000	2	500
Pasture—		lb.	
Over 25 in. rainfall	800,000	80	28,571
Under 25 in.	400,000	50	8,932
Cereal Fodder—			
Oats	305,000		
Barley	32,000	50	7,813
Wheat	13,000		
Peas, beans, rape, roots, etc. ...	34,000	50	760
Cereal Hay—			
Wheaten	167,000	50	3,723
Oaten	213,000		4,759
Cereals—			
Wheat	1,750,000		31,250
Oats	400,000	40	7,143
Barley and Rye	50,000		893
Linseed	200	50	5
Total	...	...	95,999

In subsequent years, similar principles were followed and need not be detailed.

ADMINISTRATION.

On account of the changes in agricultural activities on many farms due to a variety of causes, many arising out of the war, it was decided to ration the superphosphate quota for Western Australia on the basis of the actual cropping programme planned by each farmer.

(a) Every farmer was required to submit an application for a permit to purchase superphosphate. He was supplied with a suitable form on which to set out his cropping programme in acres for each crop which he planned to grow.

(b) This applicaion form was obtainable from all agents and was received either by the agent or manufacturer and forwarded to the Rationing Office. The agent or manufacturer was able to advise the farmer regarding the principles involved in the rationing scheme and the information required on the application form.

(c) The application form was checked at the Rationing Office in Perth. The amount of superphosphate required on the cropping programme submitted was computed and this total compared with the quota to which the farmer would be entitled based on a percentage of his purchases in previous years. Base years selected for this purpose have been 1939-40, covering pre-war conditions, and 1941-42 covering the first year under which superphosphate rationing had been carried out.

(d) Should the programme submitted involve a greater amount of superphosphate than the maximum of his quota on the basis of previous records, the permit was limited to the maximum which was either 50 per cent. of the 1939-40 purchase or 66 per cent. of the 1941-42 purchase. It was expected that additional supplies might be available from the contingency pool.

(e) Following consideration of the application, permits were issued and could be lodged with any agent together with an order for the fertiliser which could be purchased, in one or several lots, at any time prior to June 30.

(f) While the superphosphate granted was calculated on the rate permitted per acre, the Department was unable to ensure that the fertiliser was used exactly as the farmer originally planned, but he was expected to work in reasonable conformity with the programme which he originally submitted.

RATIONING IN SUBSEQUENT YEARS.

The following notes may be of interest with respect to fertiliser rationing in subsequent years:—

1943-44: The State allocation for 1943-44 was reduced to 109,281 tons, owing to the diversion of extra superphosphate to dairy farms, in view of the increasing importance of dairy produce in the war effort. States with large dairy industries benefited greatly from this policy. In consequence, the rates of superphosphate for grain crops and pastures were reduced by 25 per cent. in all cases, except for topdressing of pastures in areas under 25 inch rainfall, where the reduction was 10 per cent. Dairy pastures benefited from the supplementary allocation of 126 lbs. of superphosphate for each 100 lbs. of butter fat or 250 gallons of whole milk supplied to the industry. This supplement was designed to bring dairy farmers to 75 per cent. of their 1939-40 usage of superphosphate.

Non-priority crops, generally, were reduced to about one-third of their 1939-40 usage. Fortunately, the State quota was increased by 10,523 tons later in the year, as a result of an increase in the Commonwealth quota. An additional 1,600 tons of phosphate from Pelsart Island, utilised at the Geraldton works, resulted in the total available to Western Australia being increased to 121,404 tons. The additional superphosphate was used to meet unforeseen contingencies, and as a supplement of 7½ lbs. of superphosphate per acre for the licensed area of wheat and of malting barley.

1944-45: The Western Australian allocation in 1944-45 was 195,755 tons. Rationing was simplified by allowing an increase of 55 per cent. on all quotas for non-priority crops, and a 20 per cent. increase in the dairy supplement. The submission of cropping and top-dressing programmes was not required. Permits were issued, but in general, the machinery for rationing was very much simplified.

Owing to the unexpectedly low demands on the contingency pool, and due to a number of farmers not requiring their full quotas, a surplus of 12,000 tons remained for distribution towards the end of the year, and this was made available as a special issue to farmers licensed to crop more than five-sixths of their basic area of wheat, and for the renovation of pastures.

1945-46: The allocation to Western Australia for 1945-46 is 265,818 tons, together with a portion of the 70,000 tons set aside by the Commonwealth for allocation to ex-servicemen. Basic quotas were again increased by 55 per cent., but no increase was made in the dairy supplement. Farmers of non-priority crops will find that their quota represents over 90 per cent. of their 1939-40 purchases. Due to the dairy supplement, the quota for dairymen is in excess of the 1939-40 tonnage, but approximately equal in P_2O_5 content.

Table V. shows the rate of superphosphate per acre allowed for the various non-priority crops during the rationing period:—

TABLE V.

RATE PER ACRE FOR NON-PRIORITY CROPS.

Crop.	1942–43.	1943–44.	1944–45.	1945–46.
	lb.	lb.	lb.	lb.
Wheat	40	37·5	58	90
Oats	40	30	47	73
Barley	40	30	47	73
Rye	40	30	47	73
Hay	50	45	70	109
Green Fodder	50	45	70	109
Pasture (Rainfall Under 25 in.)	50	45	70	109
Pasture (Rainfall over 25 in.)	80	60	93	144

SUPERPHOSPHATE STATISTICS.

The rationing of superphosphate was necessarily based on statistics. These were obtained largely from the fertiliser manufacturers and in some cases from the farmer himself. In the course of four years of fertiliser rationing, a valuable body of statistics has been accumulated. As it is likely that this information will be of considerable interest to the manufacturing and distributing industries, as well as to farmers, it has been analysed and compiled for publication in this report.

Estimates were made of the usage of superphosphate for the main crops of the State for 1939-40, and for the four years of rationing. This information is given in Table VI.

TABLE VI.

ESTIMATED SUPERPHOSPHATE USAGE BY CROPS IN W.A.

Crops.	1939–40.	1942–43.	1943–44.	1944–45.	1945–46.
	tons.	tons.	tons.	tons.	tons.
Potatoes	4,250	6,000	5,250	10,500	8,000
Vegetables	3,900	5,000	6,750	6,982	6,000
Navy Beans	...	...	7	...	...
Blue Peas	...	200	200	...	...
Vegetable Seeds	...	100	113	143	150
Berry Fruits	20	...	10	2	...
Flax	...	900	1,000	1,000	1,000
Tobacco	500	750	850	700	250
Hops	15	20	15	20	20
Irrigated and Dairy Pastures ...	40,300	29,500	30,225	40,300	55,000
Other Pasture	28,830	9,000	16,500	25,600	39,500
Cereal Grain—Wheat	129,265	31,250	31,900	60,000	93,000
Cereal Grain—Oats	19,606	7,500	6,100	9,500	14,500
Cereal Grain—Barley	3,600	1,000	870	1,300	2,000
Cereal Hay and Green Feed ...	30,529	19,000	15,200	24,700	38,000
Maize Grain and Feed	230	300	200	465	400
Rye	100	100	40	60	100
All Citrus	420	400	400	620	620
Vine and Tree Fruits for Drying ...	350	300	450	700	900
Fresh and Wine Grapes	330	300	225	350	620
Bananas	60	75	75	75	75
Pome and all other Fresh Fruits ...	2,450	400	850	1,320	2,510
Green Forage	1,600	500	565	880	1,400
Grass and Small Agricultural Seeds	250	200	150	235	250
Mangels	40	...	10	15	...
Field Peas	600	200	105	160	150
Establishment of Lucerne	220	100	70	110	100
Peanuts, Passion Fruits	60	60	40	60	60
Aerodromes	...	...	...	150	150
Total	267,525	113,155	118,170	185,947	264,755
Adjustment of Anomalies ...	...	6,545	3,234	...	1,063
Contingencies Pool and Overdrawal, 1944	...	...	...	9,808	...
	267,525	119,700	121,404	195,755	265,818

In order to illustrate the position, the statistics for the years 1939-40 (which were adopted as the base throughout the Commonwealth) and 1944-45 were subjected to analysis. In this analysis the superphosphate purchases, or quotas to which farmers have been entitled, have been grouped into various tonnage ranges. Up to quotas of 10 tons, single ton units have been adopted as the range; for higher tonnages the groups have been extended, as will be observed from the tables.

Table VII. shows the number of farmers whose quotas fall within the various ranges. This information is also illustrated by the graph in Fig. 1. The height of the columns for each range indicates the number of farmers whose quotas fall within the tonnage range. The effect of superphosphate shortage and rationing in increasing the number of farmers in the lower ranges is well illustrated by this graph.

TABLE VII.

Estimated Number of Quotas in Quota Range.			Estimated Number of Quotas in each Single Ton Category.	
Quota Range.	1939–40.	1944–45.	1939–40.	1944–45.
	tons.	tons.	tons.	tons.
Under 1 ton	702	790	702	790
1½ tons— 2 tons	291	680	291	680
2½ tons— 3 tons	358	699	358	699
3½ tons— 4 tons	498	702	498	702
4½ tons— 5 tons	490	718	490	718
5½ tons— 6 tons	747	748	747	748
6½ tons— 7 tons	344	869	344	869
7½ tons— 8 tons	508	1,092	508	1,092
8½ tons— 9 tons	222	1,271	222	1,271
9½ tons— 10 tons	837	714	837	714
10½ tons— 12 tons	829	1,406	415	703
12½ tons— 15 tons	1,054	1,537	351	512
15½ tons— 20 tons	1,972	1,317	394	268
20½ tons— 25 tons	1,113	748	226	145
25½ tons— 30 tons	929	389	186	78
30½ tons— 40 tons	844	337	84	34
40½ tons— 50 tons	468	156	46	15
50½ tons— 60 tons	233	77	23	8
60½ tons— 80 tons	206	67	10	3
80½ tons—100 tons	89	23	4	1
Over 100 tons	109	21	...	...

TABLE VIII.

Estimated Tonnage of Superphosphate Purchased in Quota Range.			Estimated Tonnage of Quotas in each Single Ton Category.	
Quota Range.	1939–40.	1944–45.	1939–40.	1944–45.
	tons.	tons.	tons.	tons.
Under 1 ton	51	395	51	395
1½ tons— 2 tons	510	1,190	510	1,190
2½ tons— 3 tons	985	1,925	985	1,925
3½ tons— 4 tons	1,870	2,630	1,870	2,630
4½ tons— 5 tons	2,330	3,410	2,330	3,410
5½ tons— 6 tons	4,290	4,300	4,290	4,300
6½ tons— 7 tons	2,320	5,870	2,320	5,870
7½ tons— 8 tons	3,940	8,460	3,940	8,460
8½ tons— 9 tons	1,943	11,130	1,943	11,130
9½ tons— 10 tons	8,160	6,960	8,160	6,960
10½ tons— 12 tons	9,320	15,800	4,660	7,900
12½ tons— 15 tons	14,480	21,100	4,826	7,033
15½ tons— 20 tons	35,000	23,400	7,000	4,680
20½ tons— 25 tons	25,350	17,040	5,070	3,408
25½ tons— 30 tons	25,800	10,800	5,160	2,160
30½ tons— 40 tons	29,700	11,870	2,970	1,187
40½ tons— 50 tons	21,600	7,050	2,160	705
50½ tons— 60 tons	12,860	4,250	1,286	425
60½ tons— 80 tons	14,420	4,680	721	234
80½ tons—100 tons	8,010	2,070	400	103
Over 100 tons	15,145	2.935	...	...

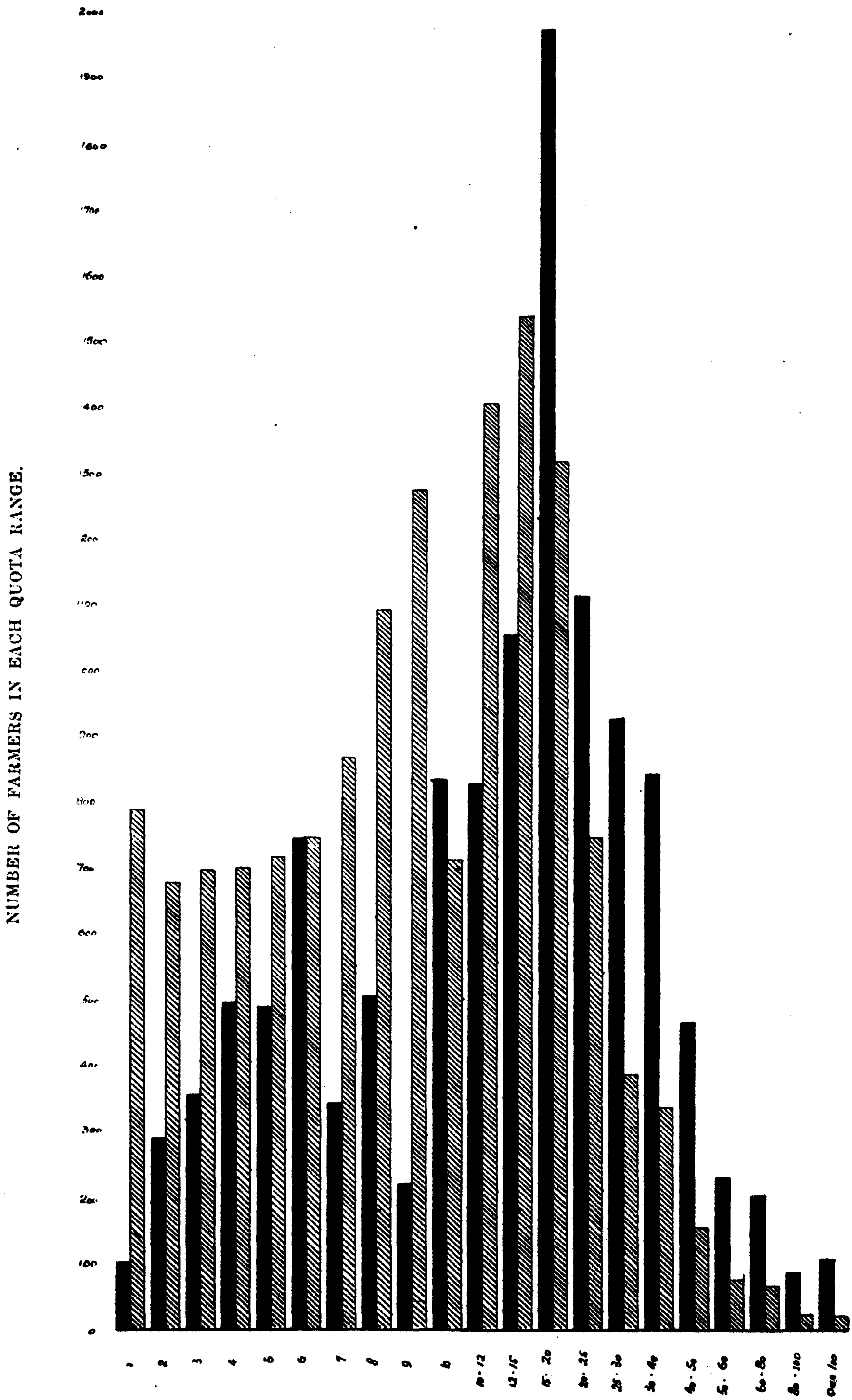


Fig. 1. Number of farmers purchasing superphosphate in each quota range.

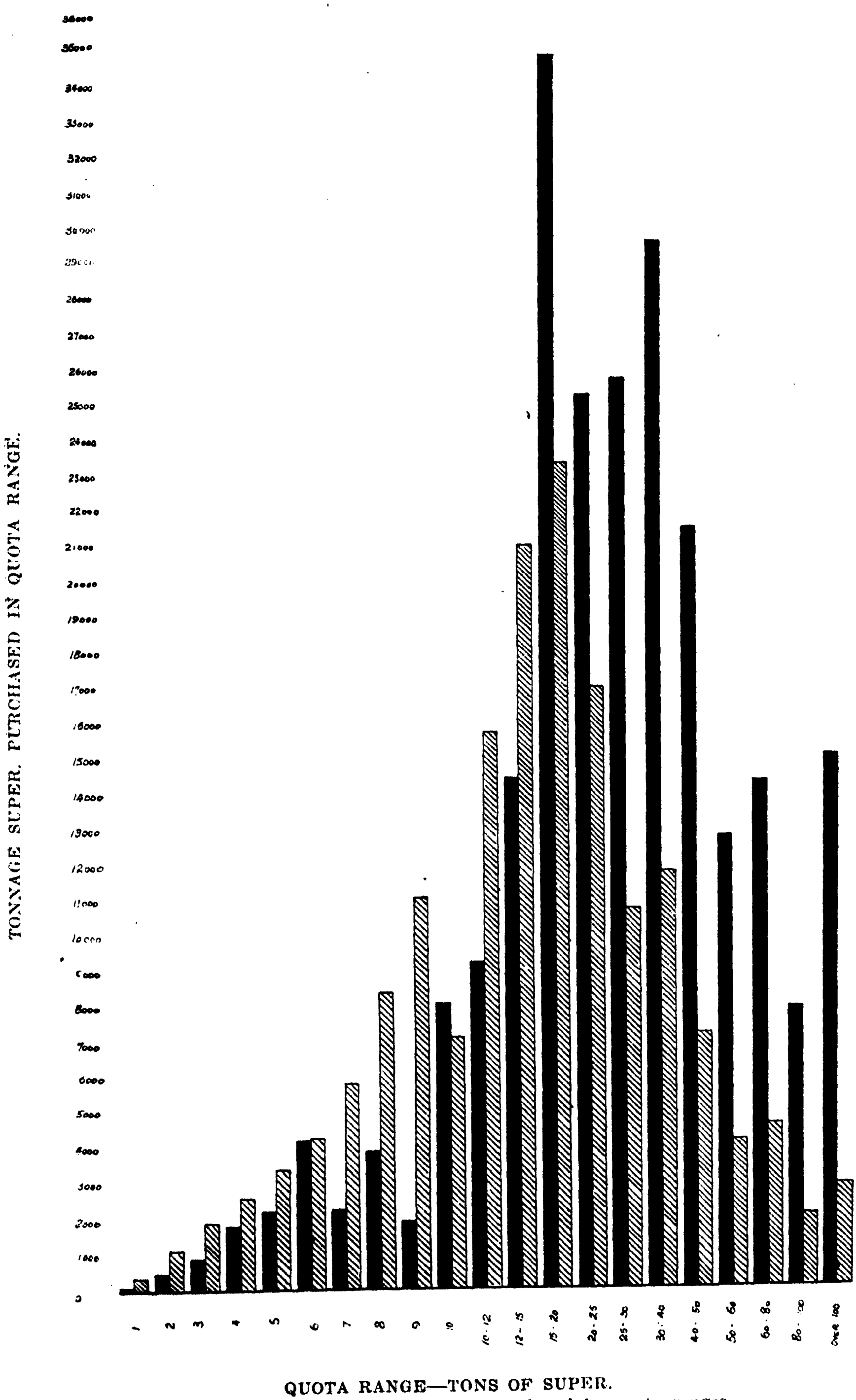


Fig. 2. Tonnage of superphosphate purchased by quota ranges.

The total amount of superphosphate purchased in each range has been estimated and the data are shown in Table VIII. This information is also illustrated by the graph in Fig. 2. The height of the columns shows the tonnage of superphosphate sold in each quota range. The solid black areas indicate 1939-40, and the hatched areas, 1944-45. Again, the shift in the tonnage to the lower ranges in 1944-45, as compared with 1939-40, is illustrated by the graph. It is of interest that the maximum tonnage in a single ton range was purchased by farmers ordering between 9½ and 10 tons. This category absorbed over 8,000 tons of superphosphate in 1939-40. In 1944-45, the 8½-9 ton range absorbed over 11,000 tons, and higher ranges were considerably smaller than for 1939-40.

The Rationing of Nitrogenous Fertilisers in Western Australia.

L. J. H. TEAKLE and D. J. COLLINS.

THE wartime shortages of nitrogenous fertilisers and difficulties in obtaining supplies from overseas, rendered it necessary to bring these commodities under National Security Regulations, in order that their distribution to users could be controlled and supplies directed to industries of greatest importance in the war effort and in the provision of food for the nation. The regulations controlling nitrogenous fertilisers were gazetted on 1st August, 1942.

The bulk of Australia's requirements of nitrogenous fertilisers prior to the war was imported. Two-thirds of the sulphate of ammonia used came from the United Kingdom, and nitrate of soda was obtained from Chile, in South America. Local production of sulphate of ammonia was obtained largely from the coking furnaces.

SULPHATE OF AMMONIA.

In the early stages of the war, it was possible to obtain shipments of sulphate of ammonia from Canada, but as the situation became more difficult, Australia had to rely almost entirely on local production. Demands were greatly enhanced, owing to the requirements for munitions manufacture and the vastly increased areas sown to priority crops, for which nitrogen is a vital fertiliser.

Prior to the war, the Australian consumption of sulphate of ammonia was approximately 52,000 tons, of which 17,000 tons was produced locally. As a result of improved recovery by the end of 1941, Commonwealth production had increased to approximately 25,000 tons. This shortage, in view of the greatly enhanced demand, rendered it necessary to control distribution.

All available supplies of sulphate of ammonia were brought under control on 3rd September, 1941, under a distribution scheme operated through Nitrogen Fertilisers Ltd., which handled the whole of the supplies on behalf of the Commonwealth Government. At this time, merchants and distributors had been forced

by a shortage of supplies to limit clients to 50 per cent. of the normal amount purchased. By the end of October, 1941, this form of rationing had broken down and stocks had reached such a low level that it was decided to reserve supplies of sulphate of ammonia not required for industrial purposes to be used in mixed fertilisers.

Under National Security Regulations, from 3rd August, 1942, the rationing of sulphate of ammonia, as well as nitrate of soda, came under the control of the Departments of Agriculture in each State. These fertilisers could be purchased in amounts in excess of 7 lbs. only with the permission of the permanent head of the State Department of Agriculture. The preparation of fertiliser mixtures by manufacturers was brought under the authority of the Departments of Agriculture, and in Western Australia, in the 1942-43 season, was limited to potato manure C, tobacco and tomato manures and potato manure D which included nitrate of soda instead of sulphate of ammonia. These were available only for potato, vegetable and tobacco crops until 1945-46.

Table I. sets out the mixed fertilisers available under the ratioinng scheme, together with the price and guaranteed analysis. A full table of registered fertilisers appeared in the December Journal of Agriculture.

TABLE I.

TABLE OF GUARANTEED ANALYSES.

Fertiliser.	Cash Price.	Nitrogen.	Potash.	Phosphoric Acid.				Remarks.
				W.S.	C.S.	A.S.	Total.	
	£ s. d.							
Potato Manure "C" or No. 2*	7 17 10	3·00	....	11·50	2·00	1·50	15·00	To 31st July, 1945.
Potato Manure "C" or No. 2*	8 4 8	3·50	....	11·00	2·00	1·50	14·50	As from 1st August, 1945.
Potato Manure "A" (C.S.M.L.)	9 15 7	2·50	5·00	10·00	1·75	1·25	13·00	C.S.M.L. ceased making "A" on 15th March, 1945.
Potato Manure "A" (CRESCO)	9 15 7	2·50	5·00	10·00	2·00	1·00	13·00	
Potato Manure "A2"	9 0 1	2·23	4·45	8·89	1·56	1·11	11·56	
Potato Manure "AM"	9 15 7	2·50	5·00	11·00	1·75	1·25	14·00	
Tomato Manure (C.S.M.L. only)	11 12 3	3·50	8·00	9·00	1·50	1·00	11·50	
Tobacco Fertiliser No. 5 (C.S.M.L. only)	8 19 4	2·80	2·50	10·87	1·88	1·25	14·00	

* The Nitrogen content of Potato Manure "C" was increased from 3·00 per cent. to 3·50 per cent. on 1st August, 1945.

The policy of strict rationing of sulphate of ammonia has been retained throughout the war period and the regulations are still being enforced. In spite of the controls, temporary shortages, largely due to transport difficulties delaying the arrival of supplies, caused some dislocation in the vegetable and potato industries, but as a rule, growers were able to secure their supplies in accordance with the ration provided for the various crops.

The supply position with respect to sulphate of ammonia improved in 1945-46 and a small tonnage has been released at the rate of 1 cwt. per acre for the dressing of citrus and dried fruit. The supply and distribution of sulphate of ammonia since 1939-40 are shown in Table II.

TABLE II.

SULPHATE OF AMMONIA.

Its Supply and Distribution.

Year.	Sold as Such.	Sold in Mixtures.	Total.
	tons.	tons.	tons.
1938–1939	...	...	4,020
1939–1940	395	2,366	2,761
1940–1941	132	1,864	1,996
1941–1942	43	1,490	1,533
1942–1943	34	1,229	1,263
1943–1944	...	1,374	1,374
1944–1945	368	1,969	2,337
1945–1946 (estimated)	1,125	2,000	3,125

NITRATE OF SODA.

Prior to the war, very little nitrate of soda was used in Western Australia for agricultural purposes. However, the acute shortage of sulphate of ammonia resulted in a demand for nitrate of soda and during the war this fertiliser became the only nitrogenous material available for topdressing of potato and vegetable crops, for horticultural purposes and for growing summer fodder crops.

In 1942-43 nitrate of soda was in such short supply that it could not be made available for orchardists other than citrus growers. However, importations improved, and in 1943-44 it was made available to all orchardists, the allocation being made on a scale according to the type of fruit grown. The allocation was improved in 1944-45, and has been maintained for 1945-46.

Table III. shows the scale of allocations for the various types of orchards.

TABLE III.

THE ALLOCATION OF NITRATE OF SODA FOR ORCHARDS.

Type of Orchard.	1942–43.	1943–44.	1944–45.	1945–46.
		cwt. per acre.	cwt. per acre.	cwt. per acre.
Citrus	small allocation	3	3	3
Fresh and Wine Grapes ...	*nil*	2	3	3
Dried Vine Grapes ...	*nil*	2	3	3
Other Fruits	*nil*	2	3	3

For topdressing, vegetables were allowed 4 cwts. per acre, and potato crops 2 cwts. per acre. Nitrate of soda was also available at the rate of 1 cwt. per acre for the growing of approved summer fodder crops for dairy purposes, in order to meet the increased demand for dairy products.

As with sulphate of ammonia, shortages of nitrate of soda occurred from time to time as a result of unsatisfactory shipping conditions. During April and May, 1945, sulphate of ammonia was substituted for nitrate of soda for top dressing vegetable crops, and it proved necessary during the summer months of 1945-46 to restrict the allocation of nitrate of soda to topdressing of vegetable and summer fodder crops.

Table IV. shows the tonnages of nitrate of soda sold during the war years.

TABLE IV.
NITRATE OF SODA.
Its Use and Distribution.

Year.	Sold as Such.	Sold in Mixtures.	Total.
	tons.	tons.	tons.
1939–1940	24	57	81
1940–1941	21	39	60
1941–1942	8	53	61
1942–1943	660	55	715
1943–1944	2,500	216	2,716
1944–1945	1,718	31	1,749
1945–1946 (estimated)	2,101	50	2,151

The Rationing of Blood and Bone Fertiliser in Western Australia.

By L. J. H. TEAKLE and D. S. HORWOOD.

MANY market gardeners and vignerons in Western Australia regard blood and bone, bone dust and similar fertilisers of animal origin as the most satisfactory basis for their manurial practice. The so called artificial fertilisers such as superphosphate, sulphate of ammonia, etc, are preferred as supplements to the more popular animal fertilisers. These animal fertilisers have been used largely for the growing of vegetables in the metropolitan areas. It is estimated that prior to the war about two-thirds of the blood and bone supplies were absorbed in this industry. The rest was used largely for the growing of vines and for potatoes.

In pre-war days vegetable growers used large applications per acre, common dressings ranging from 20 cwts. to 30 cwts. for a crop. In addition to this liberal treatment, some used extra applications as topdressings to force growth. Prior to the war growers in Western Australia used about 5,000 tons of these animal fertilisers per annum and the demand was increasing.

When the tide of war forced Australia to increase production of important foodstuffs to the maximum, special attention was devoted to the so-called priority crops, of which vegetables were high in the list. The drive for increased vegetable production commenced in March, 1942, when the first targets for increased production were placed before growers. The targets for Western Australia in successive years are shown in Table I.

TABLE I.
TARGETS FOR VEGETABLES AND POTATOES.

	1939–40.	1942–43.	1943–44.	1944–45.
	acres.	acres.	acres.	acres.
Vegetables	4,282	7,000	10,400	9,000
Potatoes	5,676	7.000	14,000	10,020

The success of this drive for production depended on a number of factors, of which not the least important was the capacity to supply the grower with his idea of fertiliser requirements. In Western Australia growers usually adjust the acreage planted to the fertiliser available, as they are convinced that economy in fertilisers means liability to serious reduction in crop yield and involves risk of failure.

The extra acreage of vegetables to be planted meant an increase in the demand for blood and bone fertiliser, and, coupled with this, was a serious falling off in the supply. Imports were halved and local production dropped about 20 per cent. The fall in local production was due largely to the closing of the Wyndham Meatworks, which produced normally about a thousand tons per annum. This loss was slightly offset by increased metropolitan production.

Table II. gives the supply position with respect to animal fertilisers over a number of years.

TABLE II.
SUPPLY OF ANIMAL FERTILISERS FROM 1935 TO 1945.
(Long Tons.)

	1935–36.	1936–37.	1937–38.	1938–39.	1939–40.	1940–41.	1941–42.	1942–43.	1943–44.	1944–45.
Local Production	2,006	2,358	2,760	2,893	2,816	2,663	2,289	2,289	2,357	2,079
Imports	1,666	2,289	1,586	1,930	1,702	2,508	2,410	1,110	1,533	1,021
Total	3,672	4,647	4,346	4,823	4,518	5,171	4,699	3,399	3,890	3,100

Accompanying the demand commencing in early 1942 for increased production and the increased fertiliser requirements, were the mounting difficulties in securing supplies from the Eastern States. In the period of shortage many growers were unable to secure their requirements. The situation caused considerable concern amongst traders and the attention of the Department of Agriculture was drawn to the problem. As a result, a voluntary rationing scheme was introduced in April, 1942. Animal fertilisers were reserved for vegetable growing and the merchants pledged themselves to sell only to bona fide market gardeners. In view of the importance of vegetable seed production in 1942, a special priority was accorded this industry and in May, 1942, a permit system was introduced to ensure a supply of blood and bone to producers of vegetable seed.

Meanwhile, the difficulties of importers increased. Some Eastern States exporters decided to relinquish interstate trade for their local markets. Pending the organisation of a Commonwealth-wide system for the distribution of animal fertilisers, it was necessary to devise a rationing scheme in Western Australia to ensure that vegetable growers would share in the supplies as equitably as possible. The voluntary scheme had failed to meet these requirements.

To meet the conditions a draft proposal was drawn up by the Department of Agriculture and placed before the distributors in September, 1942, as a basis for machinery to ration animal fertilisers within the established trade organisation. The proposal was supported by the Market Gardeners' Association. Arising out of the discussions between the Department of Agriculture, the merchants and the market gardeners, a rationing scheme was decided upon and adopted in December, 1942.

This scheme was based upon the following principles:—

1. Animal fertilisers would be restricted to vegetable and potato crops and to the production of vegetable seeds.

2. Growers requiring animal fertilisers for these crops should submit an application to the Department of Agriculture, giving particulars regarding the crops to be grown and the acreages involved.
3. The application would be checked and endorsed by an officer of the Department of Agriculture engaged in advisory and inspectorial work in the vegetable growing districts.
4. The Fertiliser Rationing Office would issue a permit for the supply of animal fertiliser, according to a scale of allocations for the crops, covering a period of three months.
5. At first the permit was issued to the grower and his agent was advised by a duplicate. Supply was obtained by presenting the permit to an agent who would endorse it with the date and quantity delivered. Unfortunately, this method involved difficulties and in 1943 arrangements were made to issue permits to the nominated agent. The grower was advised of the quantity of fertiliser to which he was entitled and was expected to procure it from the agent holding the permit.

Fertiliser Control Regulations under the National Security Act, to include animal fertilisers and feeding meals, were gazetted by the Commonwealth Government on August 31st, 1942. Under these regulations the export of animal fertiliser from Australia was prohibited and the control of sales within the States vested in the permanent heads of the Departments of Agriculture.

The Australian production was examined by the Agricultural Council and it was arranged that representatives of the Departments of Agriculture of the several States concerned should confer and agree upon an equitable distribution of the manufactured product. In October, 1942, agreement was reached whereby purchases during the two preceding years should constitute a base for calculating the quota to be released to the importing States. The chief exporting States—New South Wales and Victoria—agreed to facilitate the supply of animal fertiliser on this basis.

The Victorian Department of Agriculture established a formal rationing scheme and each year determined a quota which it was hoped could be supplied to the importing States. On the basis of the purchases in the base years, the Victorian quota for Western Australia amounted to 12.8 per cent. of the total Victorian production. New South Wales agreed to facilitate exports, but owing to shipping and other difficulties, it proved impossible to export regular supplies.

During the first seven months of rationing, animal fertiliser was allocated to growers at a flat rate of 10 cwts. per acre for all vegetables. However, with the increasing acreage sown to vegetables, this ration proved too liberal in relation to supplies and had to be reduced. A new scale was adopted and vegetable crops were divided into three categories, only two of which were eligible for a ration of animal fertiliser.

Schedule 1—Ration 6 cwts. per acre.

Bananas	Cauliflowers
Potatoes	Lettuce
Cabbages	Rhubarb
Tomatoes	Celery
Silver Beet	Runner Beans
Onions	French Beans
Parsnips	Herbs
Carrots	

Schedule 2—Ration 3 cwts. per acre.

Green Peas	Spinach
Beetroot	Sweet Potatoes
Leeks	Swedes
Turnips	

Schedule 3.

All other vegetables.

Rationing proceeded smoothly during 1942-43, although permits issued were slightly in excess of the supplies, as shown by the following figures:—

Supplies for Year Ending 30th June, 1943.

	Tons.
Imports	1,110
Local Production	2,289
Permits Issued	3,512

The same general rationing scheme operated in subsequent years, and the demand was equated to the supply satisfactorily until the 1944-45 season, when the tonnage available was the lowest for ten years.

The supply position further deteriorated and in 1945-46 it proved necessary to reduce the allocations. Commencing on October 1st, 1945, the allocations were fixed at 5 cwts. per acre for crops in Schedule 1 and 2½ cwts. per acre for crops in Schedule 2. As the shortage persisted, the allocations were further reduced as from 1st January, 1946, to 3 cwts. and 1½ cwts. per acre, respectively, for Schdules 1 and 2. By this means it is hoped that a small reserve will be built up to meet the increased demands for animal fertiliser during the winter months.

The re-opening of the Wyndham Meatworks in 1945 relieved the situation slightly, with a production of 328 tons. It is hoped that during the coming year this production may be very greatly increased.

DISCUSSION.

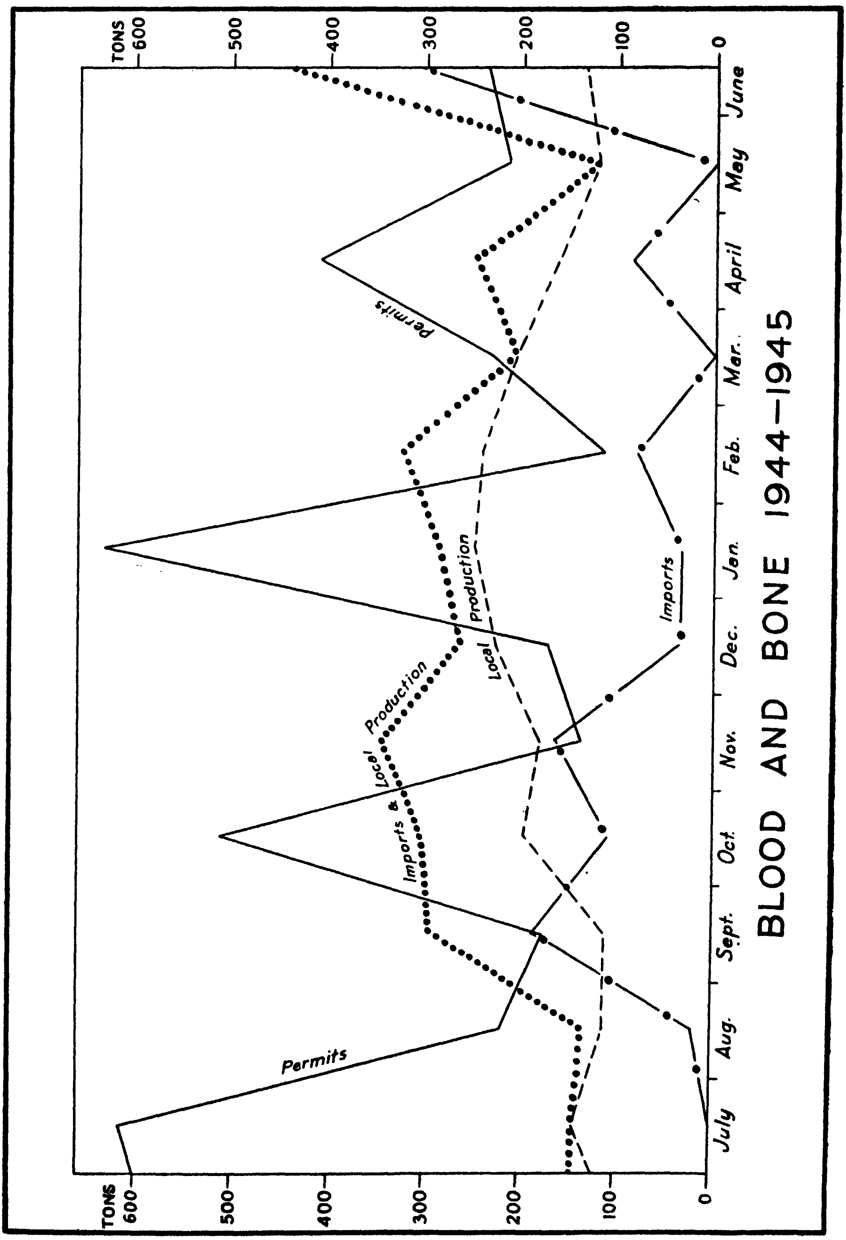
The problems encountered in the rationing of animal fertiliser are illustrated by the accompanying diagram, which sets out the salient features for the year 1944-45. It may be noted that the permits issued show two main peaks and two minor peaks. The quarters of heaviest demand are January-March and July-September. Against this, the supply is far from constant. Local production reaches its highest point in January, with fairly even gradients on either side. Unfortunately, the imports are subject to violent fluctuations. During 1944-45 there were no imports for three months; for four months the importation was under 100 tons; while for the month of June it rose to over 300 tons.

It can be understood that these variations in supply and demand have rendered rationing difficult and have meant that growers have at times been unable to secure their quotas of animal fertiliser when required.

Everything possible was done to maintain an even supply of animal fertiliser by representations to the shipping authorities and the exporters in the Eastern States. War-time conditions, coupled with unprecedented droughts, were responsible for the difficulties. It is pleasing to record that the heartiest co-operation was received from the Departments of Agriculture in Victoria and New South Wales in efforts to relieve the position.

Now that the war is over, it is anticipated that the acreages of vegetable crops planted will decrease and the demand will ease. It is not expected, however, that imports from the Eastern States will reach pre-war figures as there is evidence

of a growing realisation of the value of animal fertilisers throughout Australia. There seems no alternative to growers making greater use of artificial fertilisers in the production of vegetable crops, and experiments carried out by the Department of Agriculture indicate that, under suitable systems of management, and maintenance of the soil organic matter, animal fertilisers can be replaced by artificials without loss of yield or quality.



Rationing of Feeding Meals, 1944-45.

By L. J. H. TEAKLE and D. S. HORWOOD.

A COMPREHENSIVE account of the rationing of feeding meals up to June 30, 1944, was published by Teakle and Needham in the September, 1944, issue of this Journal. The present report covers operations during 1944-45 and gives later statistics showing the position during a very difficult year. As in previous years, basal allocations were made to growers in accordance with the number of stock being fed and monthly rations were adjusted to the anticipated available tonnage. Rationing was based on an expectation of 67 tons of feeding meal per month for pigs and 156 tons for poultry.

Statistics showing the supplies of meatmeal available to the State during the six years ending 30th June, 1945, are given in Table I. The weights are expressed in long tons and an error in the figures published in the earlier report, arising out of the partial use of short tons in the industry has been corrected.

TABLE I.
(Long Tons.)

Year.	Imports.	Local Production.	Total.
1939–40	1,950	523	2,473
1940–41	2,292	761	3,053
1941–42	1,417	606	2,023
1942–43	1,436	744	2,180
1943–44	1,669	988	2,657
1944–45	1,169	1,100	2,269

Local production during the year improved to the extent of 150 tons net by the manufacture of a feeding meal from crude pig offal. This meal has been used largely for pig feeding.

For 1944-45 the allocation of meatmeal to permit-holders amounted to 1,839 tons for poultry and 805 tons for pigs. In addition, 54 tons were sold in mashes outside the permit system, bringing the total to 2,698 tons. Against this, the supply was only 2,269 tons. Although the supply position was difficult through much of the year, the ration was not reduced until 1st July, 1945, owing to the continued expectation of substantial imports from Eastern States' sources as indicated by the allotted import quotas. However, the severe drought conditions, combined with shipping difficulties, resulted in imports of only 1,169 tons, of the expected 1,700 tons, in spite of every assistance from officers of the Departments of Agriculture of Victoria and New South Wales.

Monthly statistics showing allocations and supplies are given in Table II. Fig. 1 illustrates the position and may be studied in conjunction with the data set out in Table II.

It will be seen from this data that imports were below the expectation of 140 tons in every month of the year except August and April, when 186 tons and 302 tons, respectively, were obtained from the Eastern States. Months with conspicuously low imports were March (zero), September (27 tons), July (51 tons).

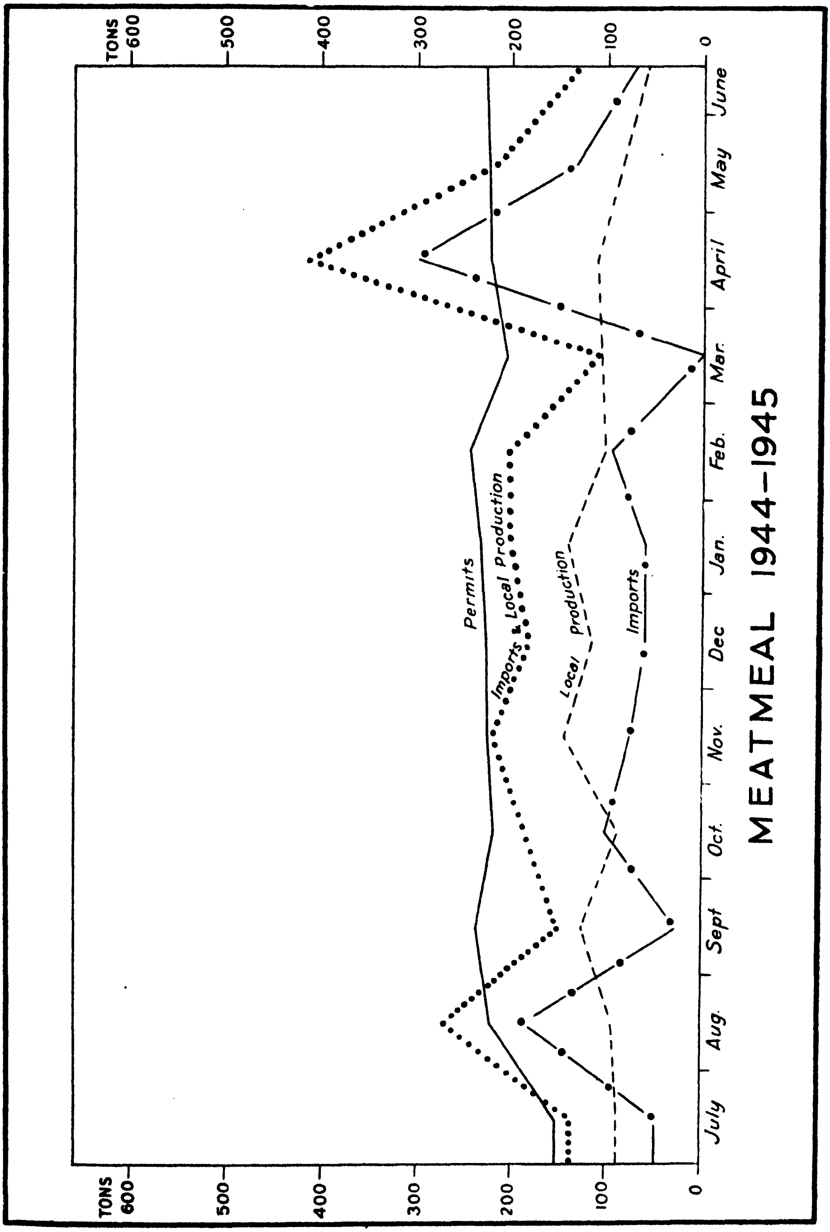

TONS
600
500
400
300
200
100
0
July
Aug.
Sept
Oct.
Nov.
Dec
Jan.
Feb.
Mar.
April
May
June
Permits
Imports & Local Production
Local production
Imports
MEATMEAL 1944–1945

TABLE II.

SUPPLIES OF FEEDING MEALS AND MONTHLY ISSUES OF PERMITS 1944-45.

(Long Tons.)

	Pigs.			Poultry.			Supplies.			
Month.	Basal Allocation.	Per cent. of Reduction.	Purchases Allowed.	Basal Allocation.	Per cent. of Reduction.	Purchases Allowed.	Total Purchases Allowed.	Imports.	*Local Production.	Total.
1944.	tons.		tons.	tons.		tons.	tons.	tons.	tons.	tons.
July	40	10	36	133	10	120	156	51	89	140
August	74	10	67	172	10	155	222	186	96	282
September	83	10	75	183	10	165	240	27	135	162
October	89	25	67	191	20	153	220	101	88	189
November	93	25	70	195	20	156	226	78	143	221
December	93	25	70	196	20	157	227	62	118	180
1945.										
January	99	25	74	200	20	160	234	60	140	200
February	107	25	80	204	20	163	243	97	103	200
March	107	40	64	204	30	143	207	...	109	109
April	110	40	66	206	25	155	221	302	110	412
May	112	40	67	207	25	155	222	134	83	217
June	115	40	69	210	25	157	226	71	60	131
	1122	...	805	2301	...	1839	2644	1169	1274	2443
Monthly Average ...	93·5	...	67	192	...	153	...	...	...	...
Per cent. of Basal Quota	...	...	72	...	...	80	...	...	...	...

* Gross figures submitted by manufacturers; a loss of 174 tons was incurred in processing and through wastage.

The prospects for the supply of feeding meals from the Eastern States for 1945-46 are not encouraging and the ration has had to be reduced in accordance with expected supplies.

It is the purpose of the rationing scheme to ensure that, as far as possible, every user will be able to purchase his full entitlement during the period of acute shortage.

The Eradication of St. John's Wort in Western Australia.

A. L. HAMILTON, Dairy Adviser.

ST. John's Wort, a noxious weed, is native to temperate regions of Europe and Asia, where, apparently, it has not proved troublesome. However, it has been introduced into the United States of America from where stock losses have been reported, and into Australia, where it has assumed major economic importance. In New South Wales and Victoria, it is regarded as one of the most serious weeds requiring eradication, or control, and it has been reported to a lesser extent in Tasmania, South Australia and Western Australia.

The spread of this weed in this State has apparently followed the development noted in New South Wales and Victoria, in that the rate of increase in the first instance was slow. After a lapse of time the rate assumed alarming proportions, and, in the latter two States, large areas of land rapidly became infested and were rendered useless for the growth of pasture, and for cultivation. By 1931, 244,519 acres in Victoria were infested, and large sums of money are still expended annually in control. In New South Wales it is no less serious and is declared an important noxious weed in 22 shires and seven municipalities.

It is thought that St. John's Wort was introduced into this State some 50 years ago, but it was not until 1935 that prolific growth in the lower South-West was reported. The initial collection of specimens was made by the Government Botanist, Mr. C. A. Gardner in December, 1934. It was calculated, at that time, that approximately 70 acres were infested from Margaret River to Augusta, the more serious areas occurring on forestry property at Margaret River and surrounding the old mill site at Karridale. Patches of the weed were later reported at Cowaramup, seven miles north of Margaret River, at Flinder's Bay, and eastwards on a property east of the Alexandra Bridge over the Blackwood River. Small infestations have also been discovered in the Harvey area, at Holyoake, Pinjarra and between Greenbushes and Bridgetown.

It is a notable fact that practically all the infestations in the lower South-West can be traced back to the activities of the early timber trade, which established an extensive mill and headquarters at Karridale. The spread of the weed closely follows the banks and cuttings along which ran the old "tram tracks" used for hauling the timber to the mills, and in other instances, heavy infestations have been discovered on old sites which were originally horse yards and stables. From this it is assumed that the introduction of St. John's Wort to Western Australia followed the importation of horse feed and other material for the use of the mills per medium of the shipping, which, in the early days, continually used the port of Hamelin Bay.

Infested areas have subsequently been found on properties scattered throughout the Karridale district, and no doubt travelling stock have been the agency in the spread of the weed in these instances. Approximately fifteen privately held properties are affected, and in all but three cases the infestation is confined to quite small areas which are easily controlled by the landholder. This work is carried out annually in conjunction with the local road board. The main growth occurs on Crown lands, Forestry reserve and vacant Rural and Industries Bank holdings.

St. John's Wort is easily recognisable from a description of its more important features and its habit of growth. The plant (*Hypericum perforatum* var. *augustifolium.*) is a perennial with erect stems arising from a woody, creeping root system. The leaves, which are narrow and up to one inch long are arranged on opposite sides of the stem, and are marked with semi-transparent oil dots which are readily seen when the leaf is held up to the light. The flowers, which are carried in dense clusters at the apex of the stem, are bright yellow in colour, and consist of five pointed petals regularly arranged. The vivid yellow colour renders the plant most conspicuous during the flowering period. The relatively dark blue-green colour of the leaves and stems, makes detection fairly easy when growing among native grasses and pasture plants prior to flowering.

The plants grow in dense clumps and soon smother relatively strongly growing species. It is for this reason that eradication is important in this State. When eaten by stock, in quantity, the unpigmented portions of the skin of the animals

may be rendered ultra-sensitive to strong sunlight, and an inflamed and ulcerated condition of these portions becomes apparent and subsequent death may result. However, there has not been an instance of this toxic effect reported in this State to date, but there is a ample evidence of the smothering habit of growth of this plant in semi-cleared and open country. It is vigorous under conditions of semi-shade, but will not grow in heavily shaded forest country. Advantage has been taken of this fact in the Eastern States, where considerable areas of farm lands have been planted with pines to establish control.

With the reported serious spread of St. John's Wort in 1935 it was decided that immediate control measures should be instituted and, during 1936, trials were carried out using sodium chlorate and "Weedex" a proprietary weedicide. Because of the reduced fire risk with the latter, the total area was sprayed with a 12½ per cent. solution of this material in December, 1936. Successive sprayings were carried out in April and December, 1937, and in April, 1938, using the same strength. These treatments resulted in the destruction of the aerial growth of the plants thus preventing the formation of seeds, but, after some months, considerable regrowth was noted in all instances due to the failure of the weedicide to destroy the vigorous root system of the plants.

During this period, and for several years, grubbing and pulling were insisted on by the road board on private properties, which were infested, but it was finally apparent that little success attended these efforts. Examination of the infested areas some time after grubbing and pulling had been carefully carried out, revealed small sections of the roots of the plants which had been removed still persisting and throwing out strong leaf and stem shoots below the surface of the ground. By the following season little diminution of the total stand was apparent. Similar results were obtained on a trial area, on light sandy soil at Karridale.

The fifth spraying was carried out in November, 1938, and "Atlacide," a weedicide containing calcium and sodium chlorates and calcium chloride, was substituted for "Weedex." "Atlacide" was used as a 12½ per cent. solution, to which a small amount of "Agral 3" was added as a wetting and spreading agent. The actual rate at which the spray was applied is somewhat difficult to arrive at owing to the scattered nature of the infestations precluding the possibility of accurately measuring any particular area treated, but an estimated rate of 150 to 200 gallons of solution per acre, is arrived at by taking the total quantity of spray prepared in relation to the estimated area upon which the plants were growing. The material was applied from a 200 gallon tank on transport, with a semi-rotary pump which was connected to adjustable nozzles by two twenty feet lengths of hose. Knapsack sprays were used in order to reach areas not accessible to the transport.

The strength of the solution was reduced by 7½ per cent. during the treatment carried out in May, 1939, without a reduction in the effectiveness of the spraying, and this application was persisted with, with two treatments per year, until December, 1942.

The period from December, 1936, to December, 1942, during which time 13 separate sprayings were carried out, was typified by a substantial diminution of the vigour of the infested areas, and in addition showed some reduction of the

total area, although no single site was rendered entirely free of the weed. This meant that the same distances had to be travelled during each treatment resulting in little saving in time each year. Seed formation had been prevented during the period however, but it became apparent that the seed of St. John's Wort remained viable for long periods under south-western Australian conditions, as a fresh crop of seedlings appeared each year on the treated areas. It has been reported that the seed of this plant may germinate after a period of fifteen to thirty years.

Results at this stage indicated that, while a measure of success in eradication was being obtained and control had definitely been established, it would necessitate prolonged and costly sprayings with "Atlacide" to ensure final eradication. In view of this fact an experiment was laid down in Margaret River, using common crude salt at the rates of five tons and two and a half tons per acre. A very favourable result was obtained from the plots treated at five tons per acre, and no permanent effect on soil fertility in this 45 inch rainfall was noted. Natural grasses and some minor clovers appeared on the plots during the following year. The plots treated at the rate of two and a half tons per acre did not give a relatively satisfactory result.

An application of five tons of salt per acre was adopted in successive treatments in October, 1943, and in September, 1944. A recommendation was also made to occupiers of infested lands that the application of two to three pounds per square yard, or a good-sized handful to each plant be made in preference to the grubbing and pulling previously insisted on by the road board, and a quantity of salt was made available, at cost, for this work.

During the 1945-46 active growing period, two treatments were carried out, the main one during October, and a "follow up" was applied during January, 1946, when the plants were in full flower.

At the time of writing, i.e., after treatment with crude salt over a period of three years, it is now apparent that salt is completely effective in every instance where every plant, or every compact area receives salt at the rate of five tons per acre. The limiting factor in ensuring final, complete eradication will be the extreme difficulty which is encountered in the finding and treating every plant. This is most evident in the case of the oldest, and, probably the original infestations of Karridale, where plants are widely scattered and are growing among low scrub and dense bracken fern. The only solution to this problem appears to be repeated inspection and the application of several amounts of salt each year, during the flowering period in December and January, in order to locate the plants missed in previous treatments. In several instances compact areas which have been found on vacant blocks have been reduced by one application of salt, to the stage when it is only necessary to follow up with a few pounds of salt each year in order to kill odd seedlings on the outskirts of the salted area.

Subsequent to the reclaiming of a number of previously vacant blocks in the Karridale-Kudardup area, in connection with the Land Settlement Scheme, at least eight areas of varying size have been discovered after the completion of the 1945-46 treatment and it is reasonable to assume that further patches will be encountered as the work on these blocks proceeds. Arrangements have been made for these areas to be located, and listed for future treatment.

SUMMARY AND CONCLUSIONS.

(1) Under the south-western Australian conditions, St. John's Wort has demonstrated its ability to assume the role of a major noxious weed as in other States of the Commonwealth.

(2) It has proved an extremely tenacious plant, the final eradication of which is difficult. Treatment must e repeated over a numer of years particularly where infestations are scattered over relatively large areas.

(3) Early treatment of large infestations at Karridale, Augusta and Margaret River, with firstly "Weedex" and secondly "Atlacide," prevented seed formation for a number of years, and reduced growth and vigour to a stage where it was possible to treat the areas with crude common salt.

(4) The use of common salt has proved satisfactory in obtaining the final eradication of certain areas, particularly where growth is dense and confined, rendering it possible to treat effectively the entire area.

(5) From information gained following the preparation of previously abandoned blocks in the Karridale-Kudardup area, for soldier settlement, it has been established that the incidence of St. John's Wort is more widespread than was thought previously, and increased efforts will be necessary to bring about total eradication. This recent information confirms the belief that the plant has been widely distributed per medium of grazing stock, and it is not unlikely that patches will be found along the stock route between Karridale and Nannup and Bridgetown.

(6) Results to date indicate that it will necessitate several years of concentrated effort before the infested areas can be reported as "clean."

A Simple and Efficient Method of Rearing Queens.

By L. BLAIR, Government Apiculturist.

IN rearing queens it is always necessary to remember that queens are only reared in nature when conditions are suitable, and that is when there is an abundance of nectar and pollen coming into the hive. The exception being in case of accident or a queen being incapable of carrying on her duties, when the bees will build supersedure cells to replace a lost or failing queen.

Young life needs two essential conditions, warmth and good food. Therefore, it is essential before starting to rear queens to have your queen rearing colonies packed with young bees with plenty of nectar and pollen in the hives and also coming into them freely.

A number of apiarists get discouraged when rearing their own queens with their lack of success, and give the job up in disgust. Hereunder is outlined a method that should overcome most of the difficulties attending the old methods of transferring young larvae into prepared queen cells, with its attendant pitfalls.

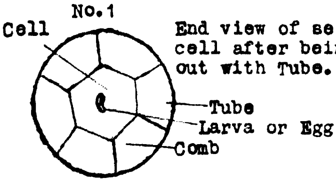
Remove queen from the hive selected to rear queens in, also all frames containing young larvae and leave for a period of five or six hours before inserting the prepared frames. The removed frames of brood could be given to the weaker colonies in the apiary or a nuclei made with the queen and brood. The bees being deprived of their queen and young brood, accept the prepared cells readily and will feed them lavishly with royal jelly, and produce well-nourished and vigorous queens.

All that is necessary is a tube made of tin or sheet brass $\frac{7}{16}$ in. in diameter and about 2ins. long; sharpen the cutting edge of the tube. Place this over the selected cell containing larvae, or if preferred, an egg just prior to its being hatched (see Sketch 1). Heat this metal tube in hot water, remove, place over selected cell, and push right through the comb with a circular movement, then remove the selected cell from the tube by means of a round tapered stick that is too large to enter the cell too deeply and crush the egg or tiny larvae. When removed from the tube cut surplus comb from the bottom of selected cell, dip into hot wax a few times to get a coating of wax—taking care not to leave in hot wax too long thus overheating the larva or egg—and then adhere to bar or bars placed in centre of frame (see Sketch No. 8). One, two or three bars of cells could be used if required. Next open or expand top of cell with tapered stick being careful not to insert too deeply to damage larva or egg. Bars on frame are attached by drilling a small hole in each end of bar and through end bar of frame. Cut nail short to enable nail head to fit flush against end bar of frame.

OPERATIONS IN TUBE METHOD.

All appliances are easily made at home.

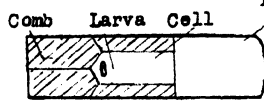
No.1



End view of selected cell after being cut out with Tube.

No.2

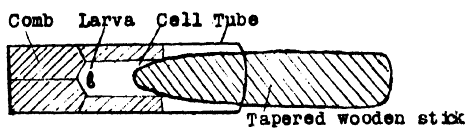
Side view of selected cell in Tube.



Selected cell unshaded with egg or young larva showing at bottom of cell.

No.3

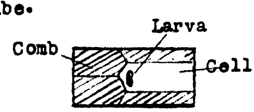
Side view of Tapered wooden plug to push out cell from Tube.



STICK small enough in shaft to move freely in tube. Parallel flat bottomed piece of wood can be used.

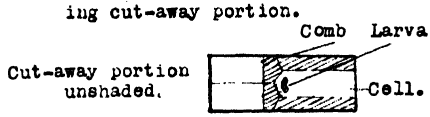
No.4

Selected cell after being removed from tube.



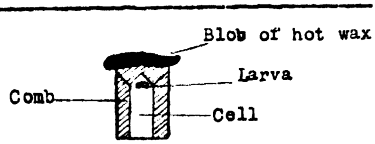
No. 5

Surplus cells removed from bottom of selected cell showing cut-away portion.



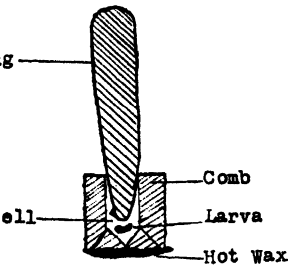
No.6

Cell ready to stick to bar.



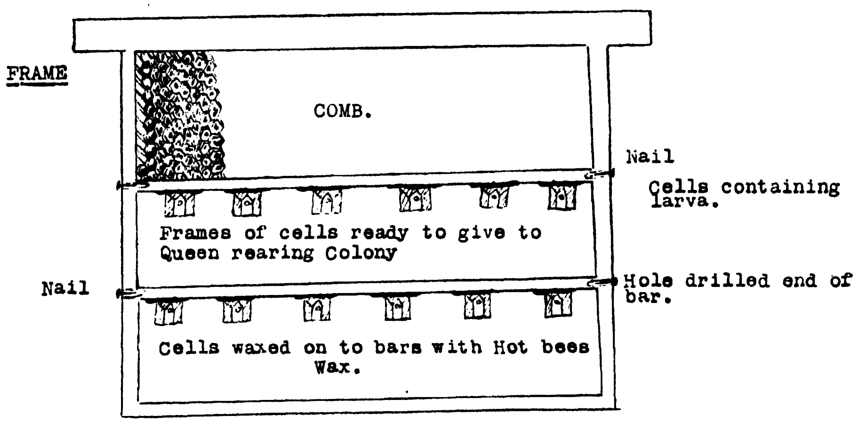
No.7
Wooden Plug with cell in position ready for dipping into Hot Wax prior to sticking to bar.

=========



To dip, only leave in hot wax a fraction of a second then, when cooled, dip again until sufficient hot wax accumulates on bottom of cell to stick to bar. Use unengaged hand to steady cell when removing plug. Only immerse cell about 1/16th or ⅛" into hot wax.

No.8
Side view of comb with cells attached to bars. Also showing method fixing bars in to frame with nail hole drilled through end Bars of frame and also into bars holding Queen Cells.



Tube can be made with a small piece of bright Kerosene or Petrol tin formed into a circular cylinder about ⅜" or 7/16th", diameter about 2" long or longer if preferred, and sharpened at cutting end. It is not necessary to solder tube at joint.

= =

POINTS TO REMEMBER.

(1) First remove queen and young brood from hive five or six hours before inserting prepared cells. Otherwise queen cells containing larvae may be started and hatch out prior to the prepared cells and will result in the good cells being torn down.

(2) Choose eggs or larvae from hive or queen who gives the best record in honey production and has other qualities to recommend her such as uniform marking of progeny, breeding long lived workers, good clean housekeepers, good comb builders, or any other traits you wish to propagate in your stock. As soon as the frames of cells are prepared, place immediately in prepared hive, otherwise larvae may get chilled and prove unacceptable to the bees. If this should happen, give another prepared frame a day later.

(3) Place prepared frames between good solid frame of pollen and honey. Carry out all queen rearing operations when the temperature is over 75 degrees and in good light. See hive is strong with plenty of young bees and make sure

honey and pollen are coming in. Seven to 21 cells should be ample for an average hive to bring cells to maturity.

(4) Remember 90 per cent. of the breeding is in the feeding. Young life must have plenty of food and warmth.

(5) Ripe queen cells will be ready for transferring to nuclei or queenless stocks in the ninth or tenth day when the operator has used larvae under 24 hours old, and a day or two later if he has used eggs just ready to hatch. If there is any difficulty in choosing larvae of the correct age, better results may be obtained by using eggs nearly ready to hatch.

(6) When transferring ripe queen cells, do not put them in a very weak hive or nuclei, keep them warm right through their cell life. Many a good queen is chilled just prior to her cutting her way out of the cell and ruins her chances of proving her quality.

(7) Always remember to leave a ripe queen cell in the hive that has just reared a batch of queen cells or if preferred, the old queen could be reunited to them. It would also be possible to divide this strong queen rearing colony into several nuclei with a ripe cell to each division. In that case it would be advisable to move divisions a couple of miles away or place in a shady spot and block entrance with grass for a few days until the bees have lost all desire to fly back to their previous location.

(8) Inspect cells a day after giving to queen rearing hive or hives to ascertain the number of cells accepted. Always have a few extra cells than actually needed.

(9) Inspect cells a day or so before ready to transfer. Make up nuclei ready to receive queen cells about a day before the cells are ready to be transferred. If possible make nuclei in an out apiary and immediately transport to apiary where queen rearing operations are being conducted. This eliminates the likelihood of the old bees in the divisions flying back to their old location, thus making the nuclei too weak to keep the new queen cell warm.

By following these instructions carefully, the majority of apiarists should be able to rear sufficient good queens to keep their apiaries up to date with good stock with practically no outlay for special queen rearing equipment.

Dairy Herd Improvement and Herd Recording.

M. CULLITY, Superintendent of Dairying.

DAIRY farmers are turning their attention to means of improving the efficiency of their operations by increasing the output of their farms. They plan to do this by keeping better quality stock, by feeding them better, and by reducing the incidence of disease.

It is the intention of the West Australian Government—with some financial assistance from the Commonwealth—to inaugurate a Herd Improvement Scheme with the objective of assisting farmers with information which will enable them to carry out their plans. The first step is the re-introduction of Grade Herd Recording with which will be associated surveys of conditions and practices. Herd wastage will be among the first problems to be considered, while a basis for making sire surveys will be included in the scheme.

Herd Recording in this State dates from 1919 when the system of measuring the yield of pure bred cows was instituted. This has continued without interruption. The recording of grade or commercial herds commenced in 1933, but

on the outbreak of war difficulties arose and, in 1942, it was decided that the men who were engaged on this work could be more profitably employed either in the Army or on urgent public works: accordingly all activities among these herds ceased. During the past two seasons, however, there has been increasing interest among farmers and—with the easing of labour supplies—the time is opportune for a resumption of activities.

Although those who have been associated with the activities in the past are familiar with the advantages of recording and the actual results obtained, there are many who may not be aware of its value and importance. It is hoped that in the coming years it will be possible to interest these in the scheme with advantage to themselves and to the State.

In 1933, when recording of grade herds started, 4,000 cows were tested for an average yield of approximately 180 lb. of butterfat, while in the final year, 1941-42, the average of those units which had a complete year was 231 lb.

There thus was an increase in average from the first year of testing of approximately 50 lb. butter fat, which—considering that the cash cost to the farmer was 2s. 6d. per cow only—was a very profitable result.

There is nothing magical about testing. The mere fact that a cow's milk is weighed and the amount of butter fat therein estimated does nothing to make her a better cow. Testing merely gives the farmer information on which he can plan intelligently to improve the output of his herd. The measurement of yields is not an end in itself, but is only a first step in approaching the objective of more intelligent and profitable dairy farming. It is the application of business method, which can be successful only if the farmer is prepared to study the records, plan, and make the effort to put his plans into operation. In other words, the improved results which I have quoted during the earlier period of herd recording were obtained only because the farmers concerned were prepared to use the information given to them as a basis for culling, for the selection of young heifers, and also in evaluing the worth of their bulls. These steps are the commonly known ways in which herd recording is used. There are others. It is no exaggeration to say that an improvement of 40 to 50 lb. butter fat per cow could be achieved in this State by improved feeding. I do not mean to infer that the purchase of concentrates is the means of better feeding, but a better use of pastures by adequate fertilisation, sub-division, a proper adjustment of the numbers of stock, the provision of a suitable number of watering points, combined with the conservation of sufficient hay and silage will allow full feeding of the herd with the minimum of expense for purchased feed. The regular testing of the herd enables the farmer to appreciate fully the variations in production which follow changes in feeding, and so helps him fix on those methods which suit best the conditions of his farm. It brings about better feeding, more thorough milking and keener management of the herd, the pastures and the farm.

The monthly visit of the recorder is in itself a stimulus to greater interest. It provides an opportunity for the farmer to discuss some of the problems confronting him and to make comparisons of his methods of feeding and management with those of other farmers.

It has been shown on various occasions in the past that the farmer who submits his herd for testing regularly enlists more readily in time of need the support of the banker, mortgagee or other creditors. This is due to their appreciation of the value of the service. Not the least important advantage which has come from herd recording has been the accumulation of data which has had an influence on the average management of herds. Probably the best demonstration of this is the evidence accumulated over a period of years that early calving is

profitable. The study of over 41,000 lactations has shown that highest productions have been given by those cows which calved during the months of April, May, June and July. The consistency of the results over the whole of the dairying districts was remarkable. There were some variations. For example, in the south coastal districts it may be expected that no loss of yield would follow calving in July and August. In the irrigation areas, the data shows that where there is ample green feed during the summer month, the differences in yield according to the month of calving are not so great.

The collection of additional data can give information bearing on other aspects of management, and it is intended that in the new scheme an extended service will be given in this way. It has been said by some farmers in the past that the recorders want too much information, and that they, the farmers, are content with knowing the comparative yields of their cows.

This is not a progressive outlook, and no apology will be given for asking the testing farmers for still more information. The cost of testing is considerably higher than the charge to the farmer, and it is unlikely that they will be reluctant to assist with the evidence which will benefit their industry generally.

In the future an effort will be made to obtain some reliable evidence regarding the causes of wastage in dairy herds.

Farmers find that the average working life of a dairy cow is relatively short. Some cows stay in the herds for many years, while others are culled quickly. The causes of losses in the herds are briefly—deaths, sales of low producers and sales or destruction of stock unsuitable for dairying on account of disease, such as tuberculosis, actinomycosis, contagious abortion, mastitis, or sterility.

Up to the present there is no evidence to indicate how serious these losses are. Individual farmers are known to have been made almost bankrupt by sudden storms of abortion, mastitis and sterility, but there is no means of calculating the annual cost to the industry. Some preliminary wastage figures which were collected in this State during 1941-42 and a survey conducted in the Brunswick district for some years earlier showed that there was an annual wastage of approximately 17 per cent. The average wastage as shown by herd testing reports for New Zealand for the five years 1938-43 was 16·8 per cent. It may be assumed for the purpose of making an estimation that the causes of wastage in the two countries are very similar. It has been calculated that the annual loss in New Zealand due to mastitis is £1,250,000, while that due to abortion is £500,000. New Zealand has approximately 14 times more cows than West Australia, and if the incidence of those diseases is about the same the annual costs to West Australia are estimated to be £90,000 and £36,000 or a total of £126,000 for these two diseases only.

There is thus a new real object in having this wastage information. It will indicate the various causes in their relative importance, and it is direct and convincing evidence of the seriousness of the position and can be used as a basis for a proper approach to attack it. As an indication of the value of a direct attack on a disease, the saving in New Zealand resulting from the vaccination of heifers against brucella abortus has been calculated—from the evidence of a reduction of the incidence of abortion in two-year-old heifers to three per cent.—as being £250,000. If the same incidence existed in West Australia and the same reduction in abortions occured following vaccination, it would mean a saving of nearly £18,000 per annum.

The urgency of collecting this data, therefore, may be readily understood.

It is intended also that with the new scheme provision for the issue of sire surveys will be made. It will not be possible to do much in this way until after two or three years' testing, but the necessary preliminary step will be taken in the marking for identification of all heifer calves and the keeping of a register, so that later when these calves come into production it will be possible to segregate their production records according to the sires, and in comparison with the yields of their dams.

So far, in the history of the dairying industry in this State, reliance has been placed—for the selection of bulls—on the performance of the nearest female ancestors, and it is certain that this policy has been successful. That the dairy farmer of this State probably has a keen appreciation of the value of continuity of breeding from standard bulls of one pure breed is demonstrated clearly by the fact that over 80 per cent. of our dairy bulls are pure bred. The method used is that known as "grading up" to a pure breed and the results can be seen in most herds. However, as the quality of herds improve, it becomes increasingly difficult to find bulls which will continue the improvement and therefore it becomes necessary to find bulls which are proven to beget daughters which are better than their dams. The continued use of these bulls will enable the general quality of the herds to rise.

The new scheme will commence in May and already there is ample evidence of the desire of a large number of farmers to participate and gain the information which will enable them to improve the efficiency of their operations.

Herd recording is not a competition between farmers, districts, or States, and therefore the present low production is the most urgent reason for putting a herd under test. The greatest and most rapid benefit will be obtained by those whose herd averages are low and who desire to apply themselves intelligently to the task of improvement.

RULES GOVERNING THE FORMATION AND OPERATION OF THE WEST AUSTRALIAN HERD IMPROVEMENT SCHEME.

1. The Superintendent of Dairying shall control the formation and administration of the Herd Improvement Scheme.

2. The State shall be considered as one Herd Recording Association.

3. Units within the association may be formed and conducted in suitable centres in dairying districts, and shall be in compact areas so as to avoid lengthy travelling by the Herd Recorder in carrying out his duties. Each unit shall contain approximately 20-25 dairy herds, comprising a total of not less than 350 cows.

4. Each unit shall be given a letter for identification and recording purposes.

5. Every member shall undertake to effect the culling from the herd of all cows which, having reached the age of six years, have failed in each of two lactation periods to produce 150 lb. of butter-fat.

6. Each member of a unit undertakes that, within three (3) years from entering his herd for recording, he shall own a pure-bred bull ex a cow which has achieved the standard for production prescribed by the rules of the Pure Breeds Herd Recording Scheme.

7. Members shall undertake not to rear any bulls to be sold for use as sires in dairy herds unless they are ex pure-bred cows and sired by pure-bred bulls.

8. Only Herd Records in the employ and under the direct control of the Department of Agriculture shall carry out Herd Recording under this scheme.

9. The official recording year shall cover the period from 1st May to the following 30th April. New units may be formed to commence operations at any period between 1st May and 31st October, and in such cases the period of the test shall be from the actual date of commencement to the following 30th April.

10. *Application for Herd Recording.*—Dairy farmers who desire to become members of the Herd Improvement Scheme and to join a unit are required to make application annually by 15th April each year on "Application Form for Testing Herd" G.H.R. form No. 2.

11. *All cows to be tested.*—Members are required to submit for testing every cow in their herds.

12. *Fees are payable as follows:*—

(a) The fee for herd recording shall be 2s. 6d. per cow per lactation period, the minimum fee being £1 5s. (i.e., fees for 10 cows).

(b) The full fee of 2s. 6d. shall be paid on the estimated number of "A" class cows to commence their lactation period by 31st October each year. When any variation occurs between the estimated and the actual number tested, the fees shall be adjusted annually.

(c) Waiving of fees in certain cases—"B" class cows. Although all cows milked *must* be submitted for test, the following may be recorded as "B" class cows. They must, however, receive this classification at the time of their first test.

i. Cows which have aborted.
ii. Strippers.
iii. Sick cows.

These cows are not charged for unless they reach 150 lb. of fat by 31st December.

iv. Nominated cows. A nominated cow is one which has calved normally but which at the time of her first test is nominated for culling. No charge is made for testing if the cow is out of the herd by 31st October.

Cows other than those mentioned above are "A" class cows, for which fees are payable.

(d) Fees for cows calving after 31st October.—The fee for cows purchased or those cows calving after 31st October in any year shall be 2s. 6d. per cow, and shall be paid as soon as testing is commenced. No further fee, however, shall become due for these cows until the next lactation period commences.

(e) Method of payment of fees.—The recording fee of 2s. 6d. shall be paid on application for the testing of a herd. Where, however, this is not possible, the sum of 1s. 3d. per cow shall be accepted with application for testing, and balance, 1s. 3d. per cow, being covered by a procuration order on a dairy produce factory payable within three months from date of issue, such order to be given at the time of application for testing.

(f) **Herds exceeding 30 in number.—Where the herd submitted for testing exceeds 30 in number the number of cows exceeding 30 need not be paid for on application, but fees for same shall be paid before 31st October or as they enter the test, whichever date is the earlier.**

Example.—A herd of 40 cows is submited. The owner may pay fees for all the cows if he desires, or he may pay the fees for 30 only, the fees for the remaining 10 cows being paid as they enter test, but payment must be completed by the 31st October. The fees paid on the 30 cows may be the full 2s. 6d. per head, or 1s. 3d. with a procuration order for the balance of 1s. 3d. per head on a dairy produce factory as per Rule 12e.

(g) For the purpose of assessing fees due to the association every cow which has been tested *once* shall be deemed to be a cow submitted for test.

(h) Recording or membership fees will not be refunded to a member after the first test of his herd has been carried out. If a member discontinues testing after the first and second test, he must continue to pay the instalments on full fee charged for each cow entered for test except with the approval of the Superintendent of Dairying.

13. *Identification of cows under test.*—The Herd Recorder shall be supplied with the following details of each cow in each member's herd: Age, colour, marks and/or brands, date of calving, sex of last calf, and also the pedigree to the extent known.

14. The following means shall be adopted to identify cows under test:—

(a) Members may have their cows individually marked for identification by tattooing in the right ear with two letters and a numeral, indicating the unit, the herd and the individual animal in that unit.

(b) Where members do not require individual identification of their cows, they shall when requested by the recorder, place in the milking shed a list with a description of all cows in the herd.

(c) Should difficulty be experienced by the recorder in recognising individual cows, he may request that individual identification as in (a) be adopted, and in such case the farmer shall give assistance in so marking the cows.

(d) Where cows have been tattooed for identification when submitted for test, as when bearing the number allotted in another unit, or purchased cows already bearing an identification mark for herd book purposes, no further identification marks are necessary.

15. *Identification of heifer calves:*—

(a) All heifer calves the progeny of "A" class cows under test shall be marked to enable individual identification.

(b) A witnessed declaration must be given in support of calf identification. If the owner is not actually caring for the herd, the declaration must be signed by the person doing this work and endorsed by the owner.

(c) The method of identification shall be as set out in rule 14a, but with the addition of a letter in the left ear to indicate the season of birth. The season commences on 1st May in each year and extends to and includes 30th April following.

(d) The calf must be marked as soon after birth as possible, preferably on the visit of the recorder following the birth of the calf.

(e) No calf shall be marked after it reaches the age of 12 months.

16. *Sampling of milk.*—The Herd Recorder shall weigh the milk yielded by each cow at each milking during the period of his visit, and shall take fair samples of each cow's milk at the rate of 1 c.c. for each pound of milk yielded at two consecutive milkings, and, after thorough mixing, shall ascertain by the Babcock method the butter-fat content of such milk. All calculations made in computing the test shall be recorded only in pounds of milk and pounds of butter-fat.

17. *Herd Recorder to give check sample.*—The Herd Recorder, when requested, shall give to the member a check sample of milk at the same time as he takes his own sample for testing.

18. *Farmer provided with daily record sheet.*—The Herd Recorder shall after each testing day, leave with the member a record or day sheet (G.H.R. 4) setting out the production of each cow for the day, and the progress production of each cow from the date of entry to test.

19. *Abnormal tests.*—In cases of cows appearing to be in normal health, but testing abnormally owing to being out of condition at time of testing, such tests shall not be registered, but an average made from the proximate and succeeding tests. When the yield of butter-fat during the 24 hours' test differs by 25 per cent. from the preceeding test, such test may be reated as abnormal. Any such sickness or abnormality shall be noted by the Herd Recorder and shown in the "remarks" column. Where the first test is abnormal, the Herd Recorder is authorised to credit such cows with milk and butter-fat production over a period of 60 days, such credit to be based on the results of the second test.

20. *Periods of recording.*—The lactation period shall consist of nine sub-periods covering respectively eight sub-periods of 30 days and one sub-period of 33 days (*vide* Rule 22). Each herd in an association shall be tested once every 30 days approximately, except during April. If it is found impractibale to make a test 30 days after the preceding test, such test may be taken not less than 25, nor more than 35 days, after the last test. The order in which the herds are tested shall be decided by the Herd Recorder.

21. No cow shall be tested unless five (5) clear days (120 hours) have elapsed since calving.

22. *Cows commencing test more than 30 days after calving.*—In cases where owners are commencing to test their herds for the first time, or where it has been found impracticable to test certain cows until after they have calved for a period of three months or more, the Herd Recorder is authorised—if he is satisfied regarding the date of calving—to credit these cows with milk and butter-fat production as shown hereunder, such credit to be based on the first 24 hour test made by the Herd Recrder.

No. of Days elapsing between calving and first test.	Period of Production credited on first test. (Days.)	No. of Tests required for 273 days lactation period.	Method of arriving at the ninth Sub-period (33 days).
5–14	30	10	Average 9th and 10th tests.
15–44	30	9	Treat 9th test as normal Sub-period.
45–74	60	8	Treat 8th test as 9th Sub-period.
75 and over	90	7	Treat 7th test as 9th Sub-period.

23. In compiling the annual report of the average production of the herd, exemptions may be allowed for such cows as have been sold, or have dried off owing to accident or sickness prior to the third testing period, also for heifers calving under 18 months of age.

24. *Production certificates.*—

(a) Certificates of production for cows which have completed their lactation periods should be made available to the owner as soon as the test is completed on the G.H.R. Form 3.

(b) Where cows have been marked individually for identification the marking must be shown on the certificate.

(c) Where marking for identification has not been used a description of the cow should be given on the certificate followed by the words, "not marked for identification."

25. *Reports to be furnished by the Herd Recorder.*—The Herd Recorder shall forward to the Superintendent of Dairying, Department of Agriculture, Perth, the following reports on the forms provided.

(a) Monthly report showing the average yield of milk and butter-fat per cow and the number of cows tested in his unit.

(b) Monthly report giving details of heifer calves marked during month.

(c) Quarterly report at the end of July, October, January and April, showing the average progress yields of each herd in his unit.

(d) Quarterly wastage report at the end of July, October, January and April, showing the number of cows which have died, or have been culled from the unit under the headings set out on the forms provided.

(e) Annual summary of the unit.

(f) Annual production report for each herd in the unit.

(g) Annual month of calving report showing the number of cows calving in each month, and the average annual production according to the month of calving.

(h) General report describing the work and any factors which have influenced production during the year.

(i) Such other reports which in the opinion of the Superintendent of Dairying are necessary for the benefit of the testing members or for the efficient operation of the Herd Improvement Scheme.

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Investigations into the "Stalling" of Subterranean Clover in the Lower Rainfall Pasture Belt of Western Australia.

G. R. W. Meadly, Assistant Government Botanist.

SUMMARY.

WITH the usual method of management, a uniform stand of even the early (Dwalganup) strain of subterranean clover cannot always be maintained in the lighter rainfall clover belt of Western Australia. After a varying period following establishment, mainly four or five years, grasses and weeds become more plentiful to the detriment of the clover content and often erodium* and cape weed† develop to such an extent that few clover plants can be found. This condition is known as a "stalled" pasture.

The belt of country concerned has an average annual rainfall of 20 inches or somewhat less, approximately 60 per cent. of which falls during May-August, the four wettest months. The four driest months, November-February, seldom contribute more than 10 per cent. and the rainfall of the remaining four months is unreliable. An appreciable range in temperature is also experienced. At Katanning the average maximum for January, the hottest month, is 86.2° while the corresponding figure for July, the coldest month, is 57.9°. The average minima for these two months are 55.9° and 41.5° respectively.

Early reports indicated that the problem was characteristic of wandoo‡ country, but although most of the stalling occurs where this tree is dominant, it is also experienced beyond the range of the wandoo.

The programme of investigations commenced in 1941 and supplemented in subsequent years in the light of information secured, was directed along the following main lines:—

1. To record the plant succession and trace the stage of diminution of subterranean clover growth.
2. To detect any soil variation which may be linked with the reduction in the stand of clover.
3. To establish and maintain clover on stalled land.
4. To ascertain the effect of the establishment of pasture grasses and various cultural treatments on the maintenance of a clover pasture.

* Erodium botrys (Cav.) Bertol.

† Cryptostemma calendulaceum (L.) R.Br.

‡ Eucalyptus redunca Schau. var elata Benth.

The work undertaken showed that the stalling of subterranean clover in the Great Southern District cannot be attributed to any single factor. It was concluded, however, that there are two dominant influences, firstly climate, especially period of rainfall, and secondly the effect of the clover and associated phosphate dressings on the soil.

Although temperature and the nature of the spring rains have a bearing on the problem, the periodicity of rains at the commencement of the season represents the major climatic factor. If falls sufficient to induce germination are followed by a long dry period, severe malting of the clover seedlings takes place, thus paving the way for dominance by the more drought resistant weed species.

Closely linked with the climatic factor is the effect of the clover growth and associated phosphate dressings on the nitrogen content of the soil, and in consequence the botanical composition of the pasture, favouring the non-leguminous weeds to the detriment of the clover. The plant population is also increased, resulting in heavier demands on the available soil moisture. When this weed phase is reached the climatic factor assumes maximum proportions and the balance inclined in favour of the weeds can be tilted completely by adverse moisture conditions, especially in the autumn.

Other factors are also concerned to a greater or lesser extent. Insects, especially red mite‡ and lucerne flea§ can play their part in reducing a stand of clover. There is also evidence of deterioration due to a deficiency of copper and possibly magnesium, but such cases are not general.

Experimental work and the experience of some farmers have shown that pastures tending to deteriorate can be revitalised by cropping. In most cases deep ploughing is inadvisable and satisfactory results have been achieved by making a dry, shallow sowing of oats, preferably with Wimmera rye grass.

The value of introducing a perennial grass has been demonstrated on small areas, but difficulty has been experienced in establishing and maintaining even the more hardy perennial species such as perennial veldt grass‖ and Phalaris tuberosa¶. The most satisfactory grass species under trial proved to be Wimmera rye grass**.

INTRODUCTION.

Although extensive areas in the Great Southern district are now under subterranean clover††, the development of pastures in this region has occurred mainly during the last twenty years with the maximum rate of progress during the last decade. Most of the initial efforts were made with the midseason or Mt. Barker strain which caused many disappointments when it failed to persist where the rainfall approximates 20 inches per annum and the growing season is also short. These unfortunate experiences caused many farmers to discount the possibilities of growing subterranean clover on their properties and did much to retard the establishment of the Dwalganup strain, which, with its earlier maturing habit, is much more suited to the conditions. This strain now covers many thousands of acres and represents the dominant component of improved pastures in the lighter rainfall areas. It was soon noted, especially in the Great Southern, however, that with the normal method of management, a uniform stand of clover could not always be maintained and after a

‡ Halotydeus destructor. § Smynthurus viridis. ‖ Ehrharta calycina Sm.
¶ Phalaris tuberosa L. ** Lolium subulatum Vis. †† Trifolium subterraneum L.

varying period following establishment, usually four or five years, grasses and weeds became more plentiful to the detriment of the clover content. Erodium (wild geranium)* and cape weed† proved to be the most troublesome intruders and in many pastures developed to such an extent that few clover plants could be found. This condition is known as a "stalled" pasture.

In 1937 a committee was formed consisting of Mr G. K. Baron Hay, Dr. L. J. H. Teakle and Mr. I. Thomas, later to be joined by Mr. M. Cullity, to initiate investigations in an endeavour to find means of preventing or correcting this deterioration of the clover stand. Experiments with which Messrs. A. S. Wild and H. G. Elliott were also closely associated were commenced in 1938. These were designed to explore the many possible causes, suggested by both farmers and technical officers. The behaviour of pastures indicated the deficiency of some minor element and the possibility of the continued use of superphosphate depleting or rendering unavailable some element such as zinc, copper or manganese could not be overlooked. A number of both field and plot trials were carried out using different combinations of these and other minor elements but no definite response was obtained. In addition various mixtures and rates of application of superphosphate, sulphate of ammonia, potash and lime were tried but the only indication of a benefit due to fertilizer application, other than superphosphate, under field conditions, was obtained with potash which in some cases was slightly beneficial.

Various systems of management involving cultivation and the sowing of Wimmera rye grass were also investigated but although a great deal of detailed information was obtained during the years 1938-40, which allowed certain factors to be eliminated when considering this problem, the committee concluded that no definite evidence that would be of major importance in overcoming the stalling of clover had been obtained.

At this stage it was decided that a special detailed investigation should be commenced. The writer was requested to undertake this investigation in collaboration with Mr. A. S. Wild. During 1941 an opportunity was taken to become thoroughly acquainted with the nature and extent of the problem but in the following year, Mr. Wild was unable to continue his association with the work and my own efforts were appreciably curtailed in this and subsequent years owing to difficulties created by the war. It is felt, however, that a deal of light has been thrown on the problem as outlined in the following pages.

SURVEY.

In the course of the preliminary survey it was ascertained that stalling of subterranean clover has been experienced over an extensive area in the Great Southern District but, in the main is confined to that zone east of the 20 inch isohyet. Similar stalling occurs in the comparable rainfall belt further north but the Great Southern is selected for particular reference as most of the observations were made and experimental work carried out in that district.

Climate.

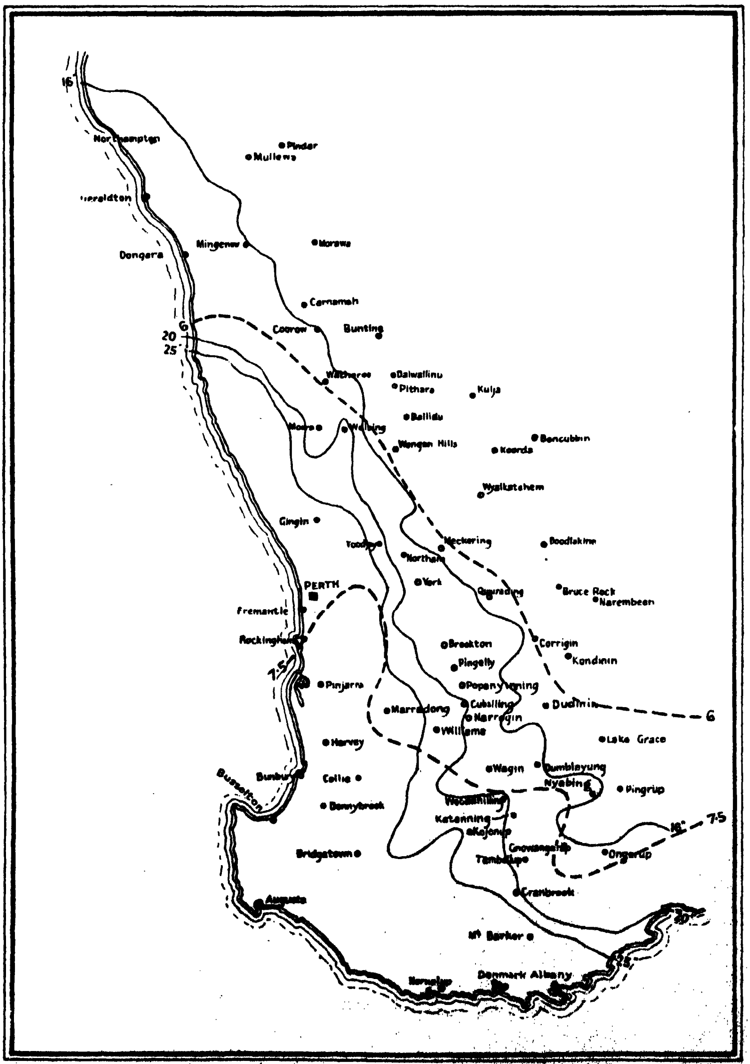
This belt of country, typically represented by such centres as Narrogin, Wagin, Katanning and Cranbrook, has an average annual rainfall of 20 inches or somewhat less, approximately 60 per cent. of which falls during May—August, the four wettest months. The four driest months, November—February, seldom contribute much more than 10 per cent. and the rainfall of the remaining four months cannot be regarded as reliable, although May—October are normally the six wettest months. Variation from the mean relative to both total rainfall and time of fall is often very marked as shown by

* Erodium botrys (Cav.) Bertol. † Cryptostemma Calendulaceum (L.) R.Br.

Table 1, and extremes represented by drought conditions and excessive rainfall have occurred in recent years.

TABLE 1.—RAINFALL.

Centre.	Annual.	Wet Season, May-Aug.	Percentages of Annual.	Dry Season, Nov.-Feb.	Annual Variation.
	points.	points.	%	points.	%
Beverley	1688	1127	67	148	20
Narrogin	2015	1269	63	196	14
Wagin	1756	1064	60	177	17
Katanning	1873	1089	58	222	17
Cranbrook	1998	1093	55	276	15



Map showing isohyets and months of influential rainfall (broken lines).

The Annual variation column represents the average percentage departure from the mean. (Figures after Gardner and Gentilli).

An appreciable range in temperature is also experienced. At Katanning the average maximum for January, the hottest month, is 86.2° while the corresponding figure for July, the coldest month, is 57.9°. The average minima for these two months are 55.9° and 41.5° respectively, while the extreme recordings over a period of 44 years have been 112.3° and 25.0°. The monthly mean relative humidity is 70% at 9 a.m. and 51% at 3 p.m., the 9 a.m. figure ranging from 87% in July to 55% in December and January. The corresponding saturation deficit figures are .171 and .378, the extreme 9 a.m. range (July-January) being .045-.324.

Although other factors such as temperature and length of day must be taken into account, the range of a particular species is governed to a large extent by the period of moisture availability. This in itself is dependent on a number of factors predominant among which are the total rainfall, the period during which it falls and the evaporation. Trumble (7, 8) has defined the "period of influential rainfall" as the time interval over which the surface soil (0-4in.) tended to be maintained above the wilting point for herbage plants. This was found to be equivalent to the period over which rainfall exceeded approximately one-third of the monthly evaporation from a free water surface. In the absence of sufficient evaporimeter records, values for the mean monthly saturation deficiency were found satisfactory for the determination of evaporation.

Basing his findings on observations in South Australia, Trumble states that it appears perfectly safe to mark the limits of the midseason strain by the 7.5 month line. Also that the earlier maturing strain (Dwalganup) has been grown successfully over a period of five years, at centres with mean values of 6.5 to 7.5 months and can probably be adopted as an improved pasture species at least to the 6.5 months line, and possibly to the 6.0 months line. The 6.0 and 7.5 lines as prepared by Trumble are marked on the appended rainfall map but do not conform closely to the practical limits of the two strains in this State, erring in the direction of exceeding the present recognised range for reasonably "safe" pastures.

Vegetation.

Earlier reports suggested that the problem was characteristic of wandoo country, but this was not found to be entirely correct. Wandoo (*Eucalyptus redunca* var. *elata*) occurs over an extensive area and varies in its associations. It is represented at its western limits by scattered trees in the jarrah forest of the Darling Range where clover stalling is not a problem. Further east, with decreasing rainfall, the wandoo becomes the dominant tree, being mainly associated with York gum (*E. foecunda* var. *loxophleba*) and jam (*Acacia acuminata*) forming open savannah-like country with low shrubby or herbaceous undergrowth. The proportion of the three major components varies considerably, the York gum and jam gradually displacing the wandoo in a northerly direction until its limits are reached at Arrino. To the south, in the vicinity of Wagin, the character of the woodland undergoes a change, the swamp yate (*E. occidentalis*) becoming of significance, especially on clay depressions, and the wandoo tending to be restricted to the light sandy soils. Further south in the Cranbrook area the wandoo ceases to be of importance and the yate (*E. cornuta*) and swamp yate dominate the woodland. Again the region under review contains appreciable

areas of mallet (*E. astringens* and *E. Gardneri*) which occur typically on lateritic formations. Although it can be said, therefore, that most of the stalling difficulties are encountered on wandoo country, all such country is not dominated by that tree and stalling also occurs in such districts as Cranbrook where the wandoo is of little significance.

Much of the stalling occurs on jam, wandoo and sheoak country depicted above.
(Photo: R. C. Rossiter.)

Soils.

With the exception of the laterite or gravel the soils are predominantly sandy or of a loamy sand varying from grey to dark brown in colour and usually of a gritty nature. Somewhat heavier soils of a finer texture are encountered on flats as the result of deposits from flood waters. There is considerable variation in the depth of the soil and at time an impervious clay layer occurs close to the surface.

Much of the laterite country immediately east of the 20 inch isohyet being of a hilly nature and difficult to work has not found favour for the establishment of subterranean clover, especially as it is being utilised for mallet re-afforestation. In consequence our experiences have been mainly with gritty sands or sandy loams which comprise the major soil type of the area.

Often a physical factor such as an impervious clay layer close to the surface has been a considerable local influence by virtue of its effect on the moisture content of the soil. Although providing useful information, such examples have little influence on the problem when considered in its entirety.

Strain of Clover.

The deterioration is commonplace among pastures established with the midseason (Mt. Barker) strain but large areas of the early (Dwalganup) strain are also affected. The major intruders associated with the diminution of the

clover content are erodium, cape weed, and annual grasses including barley§§, brome‖‖, and silver grass¶¶. Wild geranium is of most significance in this respect often growing to the exclusion of practically all other species on large areas of previously good subterranean clover pastures.

Stalling of subterranean clover of a somewhat different nature has occurred on certain soil types on the south coast and also in the vicinity of Busselton, but this is related to a copper and possibly manganese deficiency and does not come within the scope of this report.

EXPERIMENTS.

The programme of work commenced in 1941 and supplemented in subsequent years in the light of information secured, was directed along the following main lines:—

1. To record the plant succession and trace the stages of diminution of subterranean clover growth.
2. To detect any soil variation which may be linked with the reduction in the stand of clover.
3. To establish and maintain clover on stalled land.
4. To ascertain the effect of the establishment of pasture grasses and various cultural treatments on the maintenance of a clover pasture.

Plant Succession.

General observations left no doubt that good stands of clover could deteriorate until the proportion of clover became negligible, but at the commencement of this investigation no information was available as to when, within the season, the diminution in the stand could be expected to occur. Was it due to poor germination, a satisfactory germination followed by seedling destruction or failure of the plants to reach reproductive maturity resulting in no seeding down for the following season? As the answers to these questions are of fundamental importance, it was decided, by making plant counts and seed estimations, to trace the history of the clover from the time of the initial sowing.

By including weed counts it was also proposed to secure a picture of variation in the species content as the pasture developed. For this purpose, fertiliser demonstration plots established in conjunction with the Cuming Smith Mt. Lyell, Farmers Fertilisers Ltd. at Yornaning, Wagin and Kojonup were utilised. Each of these consisted of five, one fifth acre plots, treated as follows:—

1. Sown with 8 lb. of early (Dwalganup) subterranean clover seed and topdressed each year with 60 lb. of superphosphate per acre.
2. Sown with 8lb. of early (Dwalganup) subterranean clover seed and topdressed each year with 180 lb. of superphosphate per acre.
3. Natural pasture without fertilizer.
4. Sown with 8lb. of early (Dwalganup) subterranean clover seed and topdressed each year with 120 lb. of superphosphate per acre.
5. Natural pasture topdressed each year with 120 lb. of superphosphate per acre.

§§ Hordeum murinum L. and H. maritimum With.

‖‖ Bromus madritensis L., B. rubens L., B. Gussonii Parl., Serrafalcus hordeaceus (L.) Green et Godr. and S. molliformis F. Schultz.

¶¶ Vulpia myuros (L.) Gmel. and V. bromoides (L.) S. F. Gray.

An early subterranean clover pasture in the foreground. The sheep are grazing on oats, Wimmera rye grass and clover.
(Photo: R. C. Rossiter.)

Unfortunately these plots were not replicated at each site but observations over a period of five years have given a complete history of seasonal plant population, both weeds and clover, along with the amount of clover seed present in the soil at the beginning of the growing season. This latter figure represents the seeds produced during the preceding year together with an accumulation of hard seeds from previous seasons.

It was derived by taking five one-square-link samples from each plot to a depth sufficient to remove all the burrs—approximately two inches. The burrs from each spit were then separated, counted and weighed and an estimation of the seed content made by counting and weighing the seed removed by hand from triplicated one gram samples of burr, taken from each bulk plot sample. These seeds were then used for germination tests.

Seed figures are included in Table 2 and represented graphically in Graphs 1—3.

It is impossible to generalise concerning the three series of plots apart from stating that moisture during the five years since establishment has been the predominant factor in deciding the growth and botanical composition. Each series has reacted less to the total rainfall than to the period during which it fell and local conditions regarding retention of moisture in the soil have played a very important part, on occasions more than offsetting the difference in fertilizer application. In this respect the plots have shown very clearly the necessity for replications when comparisons between different treatments are to be made. They were designed originally as demonstration plots, however, and have served a very useful purpose in these investigations.

TABLE 2.

SEED ESTIMATIONS.

	Plot 1.				Plot 4.				Plot 2.			
	1942.	1943.	1944.	1945.	1942.	1943.	1944.	1945.	1942.	1943.	1944.	1945.
YORNANING.												
Weight of burrs per sq. link—grams	2·7	5·3	7·4	7·8	5·2	6·7	15·6	15·3	2·5	7·8	17·1	10·7
Number of burrs per gram	18	33	42	44	19	28	33	36	19	28	30	42
Number of seeds per gram of burr ...	60	53	58	61	63	48	66	51	67	51	71	44
Number of seeds per sq. link ...	164	271	429	473	330	322	1030	779	169	401	1216	470
Weight of seeds per gram of burr ...	0·39	0·27	0·29	0·28	0·42	0·29	0·37	0·31	0·42	0·29	0·39	0·26
Weight of one seed—gram	·006	·005	·005	·005	·007	·006	·006	·006	·006	·006	·006	·006
Equivalent lbs. per acre	232	315	472	481	481	428	1271	1044	231	498	1469	612
WAGIN.												
Weight of burrs per sq. link—grams	0·9	4·2	8·8	5·8	0·4	1·8	4·6	4·0	0·7	1·1	6·1	4·0
Number of burrs per gram	21	26	26	37	32	36	30	45	22	30	27	39
Number of seeds per gram of burr ...	72	48	67	41	92	58	85	45	73	30	73	45
Number of seeds per sq. link ...	63	202	590	237	40	104	391	181	53	33	445	179
Weight of seeds per gram of burr ...	0·42	0·36	0·44	0·25	0·48	0·35	0·49	0·27	0·42	0·22	0·50	0·32
Weight of one seed—gram	·006	·007	·007	·006	·005	·006	·006	·006	·006	·007	·007	·007
Equivalent lbs. per acre	83	333	853	319	42	138	496	237	64	53	672	282
KOJONUP.												
Weight of burrs per sq. link—grams	1·4	0·8	1·3	3·8	2·1	3·8	12·2	8·2	2·0	0·8	2·6	4·0
Number of burrs per gram	21	32	20	34	25	32	28	37	22	27	21	33
Number of seeds per gram of burr ...	69	37	61	77	74	53	72	73	70	49	60	75
Number of seeds per sq. link ...	100	30	79	296	153	201	878	599	143	39	156	302
Weight of seeds per gram of burr ...	0·51	0·25	0·48	0·46	0·50	0·32	0·47	0·41	0·48	0·42	0·45	0·43
Weight of one seed—gram	·007	·007	·008	·006	·007	·006	·007	·006	·007	·009	·008	·006
Equivalent lbs. per acre	157	44	137	385	231	267	1264	740	211	74	257	379

The total rainfall and the time at which it has fallen have proved such significant factors that it has been considered advisable to give some visual representation of each season. Although a complete block graph for the entire year proves a little unwieldy it represents the most satisfactory method of depicting wet and dry periods along with the amount of each fall. Graphs have been prepared for Narrogin, Wagin, and Kojonup (see pages 119-123). In each case the experimental site is some few miles distant from where the record was taken but the figures give a good impression of conditions at the plots. The Yornaning site is twelve miles north of Narrogin.

(a) *Yornaning.*—A dense stand of erodium and cape weed was ploughed in on 28th April, 1941, and, following harrowing, the plots were sown by hand. Although a proportion of the erodium recovered, a good first-year stand of clover developed under favourable seasonal conditions. The following season, although there was a quantity of erodium and annual grasses (mainly silver grass) present, these plants were largely obscured by a comparatively dense stand of clover which formed practically a complete ground cover on all sown plots. The erodium plants were small and unthrifty, a condition attributable to the cold winter which retards weed species such as cape weed and erodium to a much greater extent than the clover. Similar observations have been made by Cook (2) in South Australia. 1943 was a year of early opening rains but unfortunately, heavy falls at the beginning and middle of February, were not supplemented until 7th March and a further dry period was experienced between 17th April and 14th May. Although this caused a considerable loss of clover seedlings, a satisfactory stand resulted from those that persisted along with others resulting from subsequent germination. It was noticeable, however, that badly withered clover seedlings made very slow recovery. On the 120 lb. super. plots the erodium was more vigorous when associated with clover than as a component of natural pasture, thus reflecting an improvement in the soil—probably a higher nitrogen level—in the third season under clover. Good September and October rains were conducive to heavy seed setting as shown by the 1944 peaks in Graph 1. As this represents the seed in the ground at the beginning of that year, it is actually a measure of the 1943 crop along with residual hard seeds from previous seedings.

1944 was a reversal of the previous year. Good early rains produced a dense mass of seedlings, especially on the plots with the lighter super. dressings, but lack of finishing rains reacted unfavourably against seed production. It is interesting to note the seed yield trends in Graph 1, paying particular attention to 1945 which, as already mentioned, is really a measure of the previous year. Although the figure for plot 1 (60 lb. super. per acre) is not as high as that for plot 4 (120 lb. super. per acre) and equals 2 (180 lb. of super. per acre) it represents an increase on the previous year and not a decline as in the other two cases. It is impossible for the seed yield to be stepped up each year but the higher super. dressings have brought the plots to their maximum more rapidly. This is not a fixed maximum, however, and if more favourable conditions had pertained during September and October an increase may have been maintained, but under the low moisture conditions prevailing, some 67 plants per sq. link on plot 1 produced more seeds than 146 per sq. link on plot 2. The final seed yields were approximately the same but hard seeds from previous seedlings would account for more of the plot 2 total.

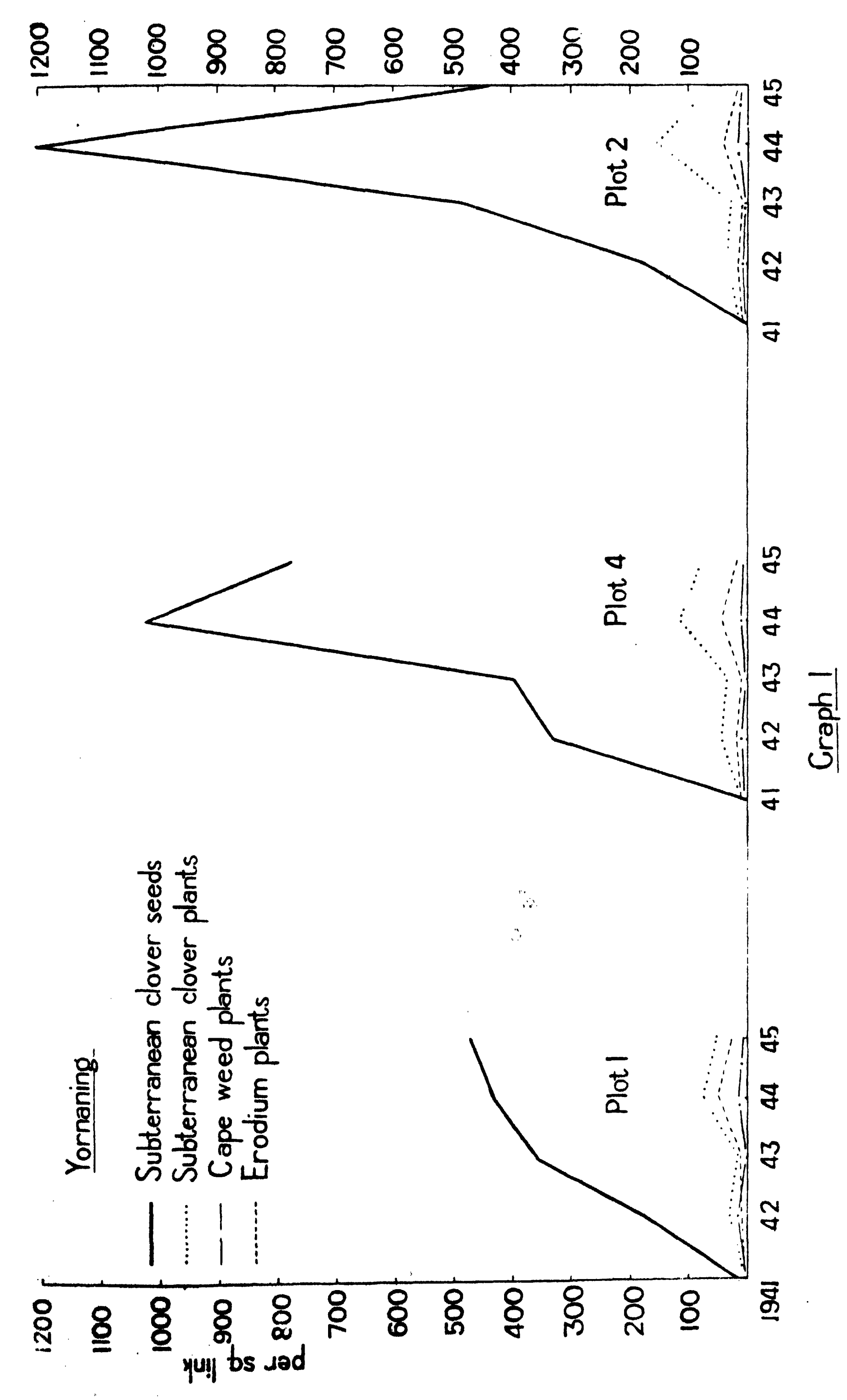

Yornaning
Subterranean clover seeds
Subterranean clover plants
Cape weed plants
Erodium plants
per sq. link
1200
1100
1000
900
800
700
600
500
400
300
200
100
Plot 1
Plot 4
Plot 2
1941 42 43 44 45
41 42 43 44 45
41 42 43 44 45
Graph I

TABLE 3.

PLANT COUNTS.

Plot.	Species.	1941.	1942.	1943.	1944.	1945.
Yornaning 1.	Subterranean clover seeds ...	5·4	164	*354	429	473
	Subterranean clover plants ...	2·1	29	20	67	51
	Erodium plants	3·4	11	11	45	26
	Capeweed plants	1·0	12	2	10	6
Yornaning 2.	Subterranean clover seeds ...	5·4	169	*489	1216	470
	Subterranean clover plants ...	2·1	27	21	146	52
	Erodium plants	3·6	11	5	39	12
	Capeweed plants	2·1	6	2	9	2
Yornaning 3.	Subterranean clover seeds ...	...	...	...	...	...
	Subterranean clover plants ...	...	...	...	...	...
	Erodium plants	3·6	21	16	...	...
	Capeweed plants	1·2	22	3	...	...
Yornaning 4.	Subterranean clover seeds ...	5·4	330	*398	1030	779
	Subterranean clover plants ...	3·0	41	30	108	73
	Erodium plants	3·6	14	5	41	150
	Capeweed plants	1·6	7	2	6	4
Yornaning 5.	Subterranean clover seeds ...	...	...	...	...	...
	Subterranean clover plants ...	...	...	...	...	...
	Erodium plants	7·2	26	19	...	...
	Capeweed plants	1·0	17	1	...	...
Wagin 1. ...	Subterranean clover seeds ...	5·4	63	*213	590	237
	Subterranean clover plants ...	1·8	7·0	10	271	51
	Erodium plants	0·6	3·2	2·3	24	4
	Capeweed plants	2·3	16	8	32	26
Wagin 2. ...	Subterranean clover seeds ...	5·4	53	*39	445	179
	Subterranean clover plants ...	1·3	4·1	9	207	18
	Erodium plants	0·3	2·1	2·0	20	6
	Capeweed plants	2·4	25	6	51	13
Wagin 3. ...	Subterranean clover seeds ...	...	...	...	...	...
	Subterranean clover plants ...	...	...	...	...	...
	Erodium plants	0·3	0·5	...	...	...
	Capeweed plants	3·8	43	...	...	...
Wagin 4. ...	Subterranean clover seeds ...	5·4	40	*111	391	181
	Subterranean clover plants ...	2·0	7·2	14	198	27
	Erodium plants	0·1	0·9	1·4	4	4
	Capeweed plants	4·6	27	6	56	26
Wagin 5. ...	Subterranean clover seeds ...	...	...	...	...	...
	Subterranean clover plants ...	...	...	...	...	...
	Erodium plants	0·2	0·8	...	...	...
	Capeweed plants	1·8	27	...	...	...
Kojonup 1. ...	Subterranean clover seeds ...	5·4	100	*31	79	296
	Subterranean clover plants ...	2·2	0·1	3·1	40	15
	Erodium plants	2·5	49	11	73	16
	Capeweed plants	0·1	0·2	0·8	0·6	0·1
Kojonup 2. ...	Subterranean clover seeds ...	5·4	143	*41	156	302
	Subterranean clover plants ...	1·5	...	1·2	57	8
	Erodium plants	2·1	51	4	120	8
	Capeweed plants	0·1	...	0·8	0·6	0·4

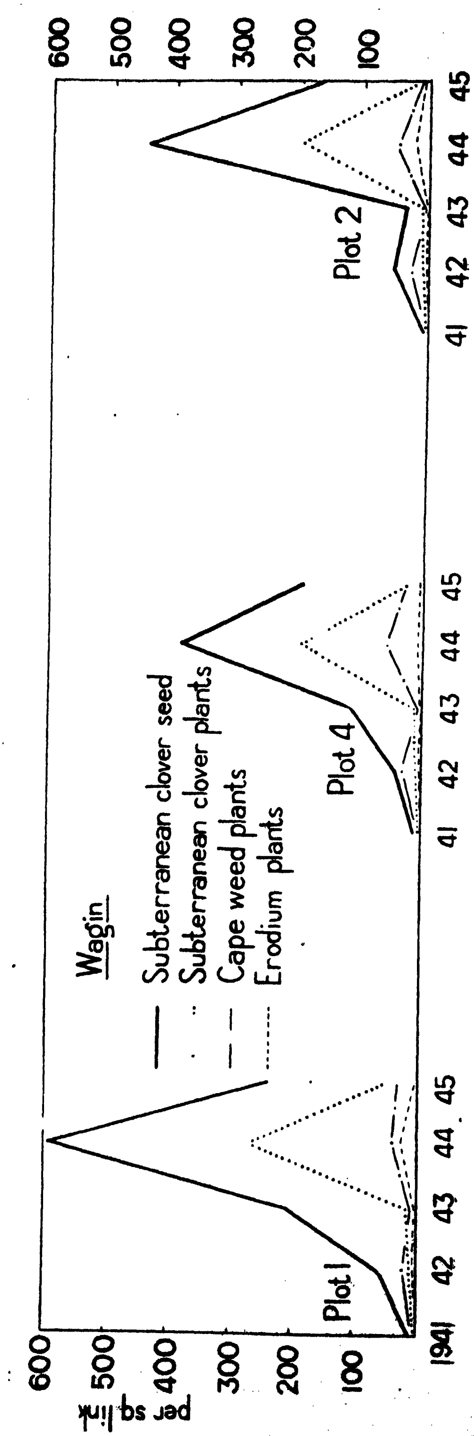
Plot.	Species.	1941.	1942.	1943.	1944.	1945.
Kojonup 3. ...	Subterranean clover seeds ...	...	...	...	...	...
	Subterranean clover plants ...	...	...	...	...	...
	Erodium plants	1·8	52	8	...	...
	Capeweed plants	0·1	...	2·3	...	...
Kojonup 4. ...	Subterranean clover seeds ...	5·4	153	*207	878	599
	Subterranean clover plants ...	2·1	2·8	7·0	140	51
	Erodium plants	3·0	51	7	58	18
	Capeweed plants	0·5	1·1	1·9	3·3	2·6
Kojonup 5. ...	Subterranean clover seeds ...	...	...	...	...	...
	Subterranean clover plants ...	...	...	...	...	...
	Erodium plants	3·0	52	11	...	...
	Capeweed plants	2·0	21·7	6·2	...	...

* Partly computed figure due to summer germination prior to sampling.

The large clover population made competition keen for the very limited supply of moisture available at the end of the season and the competitive aspect was accentuated, especially on the plots with the higher super. dressings, by the highest erodium content experienced to this stage, equivalent to some 40 plants per square link. Annual grasses, especially silver grass were more conspicuous than previously, being most apparent on plot 2, receiving the largest super. application.

A satisfactory germination, although less than that of 1944, took place in 1945, but the excessive rainfall caused the experimental site to be waterlogged for extended periods. When inspected in September the clover was very backward on all plots and the erodium had also been affected adversely. The clover present earlier in the season had disappeared entirely from sections, particularly on plot 1 which was submerged for the longest period. The presence of a small sedge in quantity was indicative of the conditions.

(b) *Wagin.*—Following necessary workings the plots were sown by hand on 30th May, 1941. Seedling establishment was somewhat less than at Yornaning but the difference did not account for the much lower seed yield. As shown by Table 2, the reduction was due, not to fewer seeds per burr, but to the formation of fewer burrs. There was a moderate stand of clover in 1942 reflecting the comparatively poor seed setting of the previous year and the soil seed supply was to a certain extent rectified. The unseasonal rains early in 1943, however, gave the pasture a further setback as many clover seedlings "malted" during the dry period following substantial March rains. The season ended favourably, however, and a satisfactory seed setting followed by an ideal growing season in 1944 resulted in a good stand of clover on all plots. That year did not end as well as it began, however, and due to the absence of spring rains, seed setting was light. Although less than at the commencement of 1944 there was sufficient immediately viable seed in the soil to produce a complete sward of excellent clover in 1945.


Wagin
Subterranean clover seed
Subterranean clover plants
Cape weed plants
Erodium plants
per sq. link
600
500
400
300
200
100
Plot 1
Plot 4
Plot 2
1941 42 43 44 45
41 42 43 44 45
41 42 43 44 45

Graph 2

The acute 1944 peaks in the clover seedling "curve" of Graph 2 can be attributed to a heavy seed setting in 1943, followed by a favourable growing season in 1944, originating the sharp upward slope and the dry spring of 1944 with associated low seed yield, contributing to the downward slope.

At no time has erodium been prominent on these plots but cape weed has been conspicuous, the number of plants showing a seasonal variation similar to that of the clover with a tendency to increase in 1945. Annual grasses have been of little consequence but clovers such as hop***, suckling†††, and woolly‡‡‡, have been plentiful in sections not dominated by the subterranean clover.

Although the curves for the individual species are similar for the three plots, they cannot be correlated with the rate of super. application. This is undoubtedly due to the fact that plot 1 is in a favoured position relative to moisture. Besides being on the lower level of a slope, there is clay near the surface and the plot obviously retains moisture longer than the remainder of the experimental site. This has been conducive to larger seed and seedling production but observations indicate that greater forage yields would be obtained from the plots receiving heavier phosphate dressings.

When an inspection was made on 22nd September, 1944, during a very dry spring, there was ample evidence to show that the density of the plant sward has an appreciable bearing on the effect of adverse climatic conditions. Where the sward was comparatively sparse the clover plants were still green and had a much better chance of seeding down than where the clover or clover plus weed content was dense. These observations support the figures already quoted for the Yornaning plots.

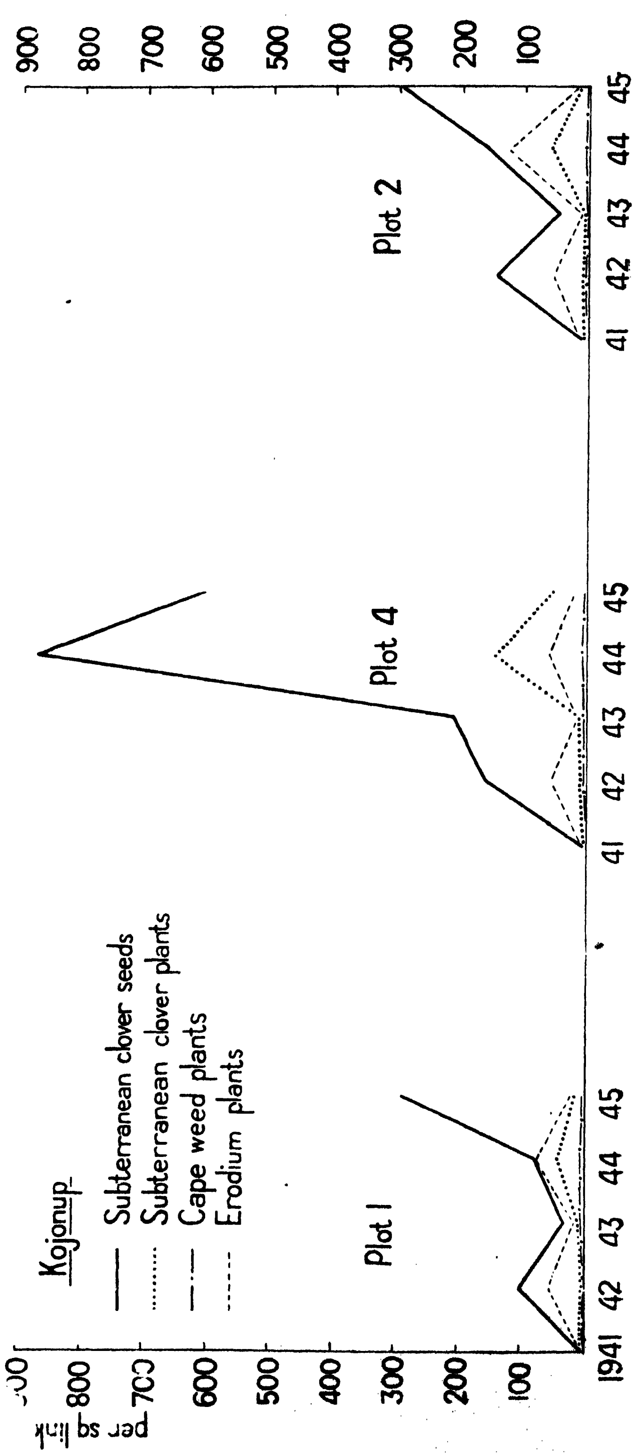
(c) *Kojonup.*—From one angle these plots proved disappointing but from another most enlightening. The plots, which prior to cultivation carried an abundant weed growth, were sown by hand on 2nd May, 1941. Vigorous plants resulted from a satisfactory germination, the other vegetation consisting of a strong growth of erodium, cape weed and minor annual clovers along with some grasses. Seed setting was good and provided the foundation for an excellent second year stand. This was not to be however, as heavy March rains induced a profuse germination, only for the majority of the seedlings to be killed by the subsequent dry period. The rainfall chart for Kojonup (see page 122) gives an indication of the autumn experienced but the registrations at the experimental site show an even greater isolation of the March fall. They were as follows:—

13th March	73 points
14th March	58 points
19th March	35 points
20th April	60 points

The 166 points was sufficient to germinate the clover along with the various weeds, but although many of the weeds, especially the erodium, survived the hot, dry month until the next fall on 20th April, the clover plants that persisted were limited to a few favoured sections relative to soil moisture.

When the plots were inspected on 30th April, few subterranean clover plants could be found except on a moist section of plot 4 and the site was dominated by a dense growth of erodium. There was evidence on other parts of the property to show that a greater survival of clover was experienced where weed competition was less. Subsequent inspections did not reveal an

*** Trifolium procumbens L. ††† T. dubium Sibth. ‡‡‡ T. tomentosum L.


Kojonup
Subterranean clover seeds
Subterranean clover plants
Cape weed plants
Erodium plants
per sq link
900
800
700
600
500
400
300
200
100
Plot 1
Plot 4
Plot 2
1941 42 43 44 45
41 42 43 44 45
41 42 43 44 45

Graph 3

improvement in the clover content of the original plots but there was a satisfactory growth on cross strips sown at the time of the April rains. This would appear to eliminate all but the climate when considering factors responsible for this example of stalling.

Those interested in this site from a pasture demonstration viewpoint wished to renovate and resow the area but in order to ascertain the capacity of the subterranean clover to recover, no treatment was given apart from the annual superphosphate application. A rapid recovery could not be expected for, with the exception of plot 4, little or no seed formation took place in 1942 and the 1943 growth was dependent on hard seeds resulting from the 1941 seed setting, i.e. the year of establishment. Unfortunately further "malting" occurred at the beginning of 1943 but scattered plants persisted on plots 1 and 2 and there was a comparatively good stand on the naturally moist plot 4. By the spring of 1944 the plots showed a marked recovery and although the clover was not dense it was healthy and competing successfully with a quantity of erodium, sorrel, and annual grasses. The cross-strips previously mentioned carried a comparatively dense stand of healthy subterranean clover up to 1ft. high.

The relatively high seed content of the soil at the beginning of 1945 indicated the possibility of an even better pasture during that year. This eventuated in the case of the cross-strips which produced an excellent stand of clover. The growth on the main plots was fair but although there was a considerable reduction in the erodium development, annual grasses were more conspicuous. It was noted that very few plants, either clover or erodium, occurred among matted brome grass§§§ resulting from the previous year's growth. This same observation had been made in other pastures where surface trash was allowed to accumulate. Such should be avoided by grazing or renovation.

As in the case of the Wagin series the variation in the moisture content of the plots more than counterbalanced any fertilizer effect as far as plant numbers were concerned and although the soil seed content of plot 4 reached a peak in 1944, plots 1 and 2 with their fewer number of plants, showed a further increase in 1945.

Observations.—Although there was only a comparatively small variation between the number of subterranean clover plants on all sown plots of the three series in the season of establishment, the following year disclosed an entirely different picture. The plants at Yornaning had increased to the extent of over 1000 per cent. while at Wagin there was an increase of somewhat more than 200 per cent. and at Kojonup a decrease of nearly 100 per cent.

The primary factors deciding the number of seedlings produced are the total number of subterranean clover seeds present in the soil linked with their immediate germinating capacity. As the plots were sown in 1941 the seed estimations made early in 1942 actually recorded the seed production during the previous year. Despite the same rate of sowing (8 lb. per acre) the seed yields at Yornaning and Kojonup were considerably in excess of Wagin. On the other hand the relationships between estimated seedlings and actual seedling establishment in 1942 were comparable at Yornaning and Wagin but Kojonup showed extreme disparity. Even with the comparable figures

§§§*Serrafalcus hordeaceus* (L.) Green et Godr.

the difference between the estimated and actual seedlings represents a wastage of approximately 70 per cent. I am unable to locate information of this nature resulting from previous work but this would appear to be a normal figure to expect in the early stages of a pasture.

The apparently heavy loss of seedlings may be attributed in part to the fact that burrs are not always in a position favourable for the germination of the enclosed seed. If the burrs are on the surface the possibility of malting is increased. Again, seedlings originating from seeds in a single burr are necessarily closely grouped thus stepping up the risk of loss due to competition. Even given optimum conditions following heavy seed setting of an established pasture there is a limit to the number of seedlings per unit of area that will survive. Apart from the physiological aspects, consideration must also be given to the depredation of insects, especially red mite and lucerne flea, which are capable of great destruction among clover seedlings.

After taking into account the normal wastage due to such factors, however, we have to look further for the practically complete elimination of seedlings at Kojonup in 1942. Although in the main this was a favourable year for subterranean clover and in many districts there was no substantial break after the opening rains in the middle of March, at Kojonup, very few plants from a substantial germination were able to survive the competition with five million erodium plants per acre for the small amount of moisture available. The drought resistance of the erodium is exemplified by the fact that a large proportion of the plants not only survived but were capable of making rapid growth with the advent of April rains.

In 1941, before being cultivated, both the Yornaning and Kojonup plots carried a dense growth of erodium but the efficiency of cultivation following the early rains in suppressing this species is shown by the low figures recorded in the 1941 plant counts (see Table 3).

In 1942, however, this species at Kojonup had increased by 1700 per cent. but at Yornaning the corresponding increase was less than 200 per cent. Possibly more dormant seeds may have remained in the soil but the fluctuation of this and other weeds at the different centres has a close linkage with the season and the condition of the soil, especially with reference to the nitrogen level as affected by the growth of subterranean and other clovers.

During the course of the investigational work particular attention has been paid to the seed aspect and, as previously mentioned, an attempt has been made to estimate seedling wastage. Table 4 summarises field observations, the results of laboratory germination tests and computed figures. For the period 1941-43 there was no reason to believe that the wastage figures derived did not represent the true position, in fact in 1942 soil germination tests under field conditions were conducted with both burr and hand cleaned seeds from the various plots, giving results which conformed with the laboratory tests. In 1944, however, a number of the plant counts made in the field exceeded the estimated seedling production. To take an extreme example, there were 1,216 seeds per square link on Yornaning plot 2 in 1944 but this was reduced to 470 in 1945, although the estimated germination based on laboratory tests was only 134. A large disparity exists without taking into consideration any seed formation in 1944.

TABLE 4.

SEEDLING WASTAGE.

——	1941.					1942.				
	a.	b.	c.	d.	e.	a.	b.	c.	d.	e.
		%			%		%			%
Yornaning 1. ...	5·4	90	4·9	2·1	— 57	164	46	75	29	— 61
4. ...	5·4	90	4·9	3·0	— 39	330	46	152	41	— 73
2. ...	5·4	90	4·9	2·1	— 57	169	44	74	27	— 64
Wagin 1.	5·4	90	4·9	1·8	— 63	63	49	31	7·0	— 77
4.	5·4	90	4·9	2·0	— 59	40	34	14	7·2	— 49
2.	5·4	90	4·9	1·3	— 73	53	37	20	4·1	— 79
Kojonup 1. ...	5·4	90	4·9	2·2	— 55	100	43	43	0·1	—100
4. ...	5·4	90	4·9	2·1	— 57	153	26	40	2·8	— 93
2. ...	5·4	90	4·9	1·4	— 71	143	40	57	...	—100

——	1943.					1944.				
	a.	b.	c.	d.	e.	a.	b.	c.	d.	e.
		%			%		%			%
Yornaning 1. ...	354	27	97	20	— 79	429	20	86	67	— 22
4. ...	398	26	92	30	— 67	1030	17	175	108	— 38
2. ...	489	23	111	21	— 81	1216	11	134	146	+ 9
Wagin 1.	213	25	54	10	— 82	590	29	171	271	+ 58
4.	111	26	29	14	—52	391	39	156	198	+ 27
2.	39	36	14	9	—36	445	33	142	207	+ 46
Kojonup 1. ...	31	...	...	3·1	...	79	31	24	40	+ 67
4. ...	207	...	...	7·0	...	878	17	140	140	...
2. ...	41	...	...	1·2	...	156	34	53	57	+ 8

——	1945.				
	a.	b.	c.	d.	e.
		%			%
Yornaning 1. ...	473	12	57	51	— 11
4. ...	779	4	31	73	+135
2. ...	470	17	80	52	— 35
Wagin 1.	237	4	9	51	+467
4.	181	5	9	27	+200
2.	179	14	25	18	— 28
Kojonup 1. ...	296	20	49	15	— 69
4. ...	599	6	36	51	+ 42
2. ...	302	24	72	8	— 89

Explanatory.

a = Seeds per square link.

b = Laboratory Germination.

c = Estimated plants per sq. link.

d = Actual plants per sq. link.

e = Percentage Variation.

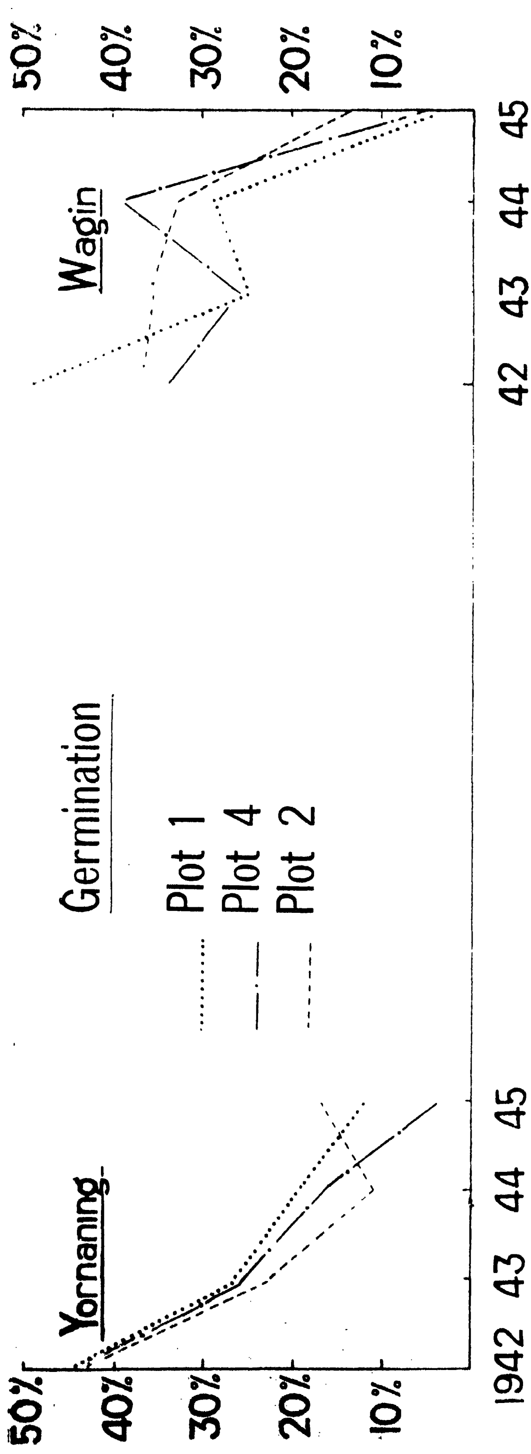
Further replications of the germination tests failed to alter the estimated figures and by reference to the seed content of the soil at the beginning of 1944 and 1945, it became obvious that the field germination in 1944 considerably exceeded the laboratory germination. The test samples were obtained when the soil seed estimations were made in January or February and we must conclude that subsequent processes in the soil substantially reduce the hard seed content and render germinable a larger proportion of the seed. Such processes may be attributable to temperature fluctuations, especially in the presence of moisture, the action of soil micro-organisms or even the "softening" of the seed coat by more direct chemical means and do not necessarily occur to the same extent each year. Although an increased germination of this nature is necessary to reconcile the estimated and actual seedling population it is possible for seeds in the ground to be destroyed by various agencies. With unprotected pastures the rabbit is a bad offender and uncontrolled fires play their part. Evidence of seed rotting has been noted both following summer rains and excessively wet winter conditions but no measurement of the significance of such losses is available.

It is apparent that laboratory germination tests are not always a reliable guide to the potentialities of a subterranean clover pasture, especially some years after establishment when normally there is an appreciable accumulation of hard seeds. The continued build up is reflected in the general decline of the laboratory germination figures for the samples taken from 1941 to 1945, especially in the last mentioned year, when, owing to a dry spring in 1944, samples from a number of plots contained few new burrs.

Although only germination figures have been given in the table, practically the entire remaining percentage in each case was comprised of hard seeds. In 1942, the year following sowing, the average germination for the nine plots was 41 per cent., but in 1945 the corresponding figure was only 12 per cent. This trend is shown clearly in Graph 4 representing the six plots for which complete figures are available. The improved seed setting in 1943, especially in the case of the Wagin plots, checked the downward movement of the graphs and, in the future, fluctuations can be expected to correspond with seasonal variations in seed formation.

Some details concerning the relationship between the burr and seed, the size of the seed and yields per acre are given in Table 2. Fluctuations due to seasonal conditions are apparent in all horizontal columns with the exception of that listing the weight of one seed. The weight of seed per gram of burr provides a good indication of the extent of seed setting during the previous year. In 1945 the "single seed weight" of the three Kojonup plots decreased but in the main this figure was comparatively uniform.

After three or four years of uninterrupted development a climax of the soil seed content can be expected although in later years the same figure may again be reached or even exceeded. It is apparent, however, from an examination of the "equivalent pounds per acre" column that three plots exceeded one-half ton of seed per acre in 1944 but owing to the comparatively poor seed setting in the dry spring of that year this figure was not reached in 1945. Such yield estimations are of value to the seed producer.


Wagin
Yornaning
Germination
Plot 1
Plot 4
Plot 2
50%
40%
30%
20%
10%
1942
42
43
44
45

Graph 4

SOIL CHEMISTRY.

As previously mentioned, prior to my association with the investigation comprehensive experimental work was carried out with various combinations of standard fertilizers and minor elements including magnesium, manganese, copper, zinc, boron, iron, antimony, tungsten, nickel, iodine, and cobalt. Following favourable reports from South Australia, molybdenum was also tried but the only indication under field conditions of a benefit due to fertilizer application other than superphosphate was obtained with potash which in some cases was slightly beneficial.

In an attempt to trace variations in the nitrogen level, soil samples taken from various sites in 1941 and 1942 were analysed by the Plant Nutrition Officer for ammonia and nitrate nitrogen. These analyses were conducted with the samples as received and then after incubation for one month in order to estimate the labile nitrogen content.

There was a certain correlation between labile nitrogen and soil type but the labile nitrogen status could not be linked with the stalling of subterranean clover. The amount of super. applied to the soil appeared to influence the quantity of ammonia produced on incubation. Mr. L. T. Jones who carried out the tests observed—"It is known that ammonification can be carried on by a wide variety of micro-organisms and also by enzymes, while nitrification is more specific. Certain of the ammonifiers may be particularly responsive to phosphate."

It was soon apparent that little conclusive information regarding variations in nitrogen status or other characteristics would be secured without a project entailing a considerable number of replications of samples taken at short intervals and commencing with the virgin soil. As a detailed project of this nature has not been possible the soil investigations have been discontinued.

ESTABLISHMENT OF CLOVER ON "STALLED" LAND.

In considering methods for the re-establishment of clover on "stalled" land, practicability was the primary consideration and bearing this in mind, cropping, along with the introduction of a suitable grass appeared to present the greatest possibilities. The following experiment was planned:—

Plot.	1941.	1942.	1943.
1.	Early subterranean clover.	Pasture.	Pasture.
2.	Oats, Wimmera rye grass, and early subterranean clover.	Pasture.	Pasture.
3.	Oats and Wimmera rye grass.	Early subterranean clover.	Pasture.
4.	Oats.	Oats and Wimmera rye grass.	Early subterranean clover.
5.	Fallow.	Oats and Wimmera rye grass.	Early subterranean clover.
6.	Control.	Control.	Control.

Experiments to conform with this time table were commenced in 1941 at the Narrogin School of Agriculture and on a property at Kojonup. Both sites were regarded as stalled clover pastures. Each plot consisted of one-fifth acre and the series at each centre was duplicated. Unfortunately it was necessary to abandon the Kojonup experiment in 1942.

All the Narrogin plots except the fallow and control were ploughed 2½in. deep and the necessary sowings made on 27th-28th May, 1941. The rates of seeding per acre were: early (Dwalganup) subterranean clover, 8 lb.; Fulgham oats, 40 lb.; Wimmera rye grass, 2 lb. and superphosphate was applied at 1 cwt. per acre. The soil was dry and friable and there was an abundant growth of erodium along with some subterranean clover. Plot 5 was later ploughed to a depth of 4in. and cultivated in the spring.

All sown plots yielded a heavy oat crop and the rye grass establishment was also good. Much of the erodium recovered following the autumn cultivation and was abundant on all except the fallow and especially on the control. Although the clover on plot 2 represented a satisfactory first year stand it was inferior to plot 1 which in turn was less dense than the control. In fact, based on the clover development of the control in this and subsequent years the "stalled" condition of preceding years was not maintained and ample evidence of a natural cycle influenced by seasonal variations was forthcoming.

In 1942, although the erodium was still plentiful there was a good stand of clover on plot 1, which closely resembled the control. The clover on plots 2 and 3 was fair with a vigorous growth of rye grass along with some self sown oats, and somewhat less erodium than on plot 1. Plot 4 carried a fair crop of oats and rye grass with sparse clover and erodium comparable with plots 2 and 3. The 1941 fallow plot was dominated by a tall, dense growth of cape weed which smothered all other species. This was mown when the cape weed commenced to flower in the spring.

The following year plots 1-3 showed little variation from 1942, erodium still being plentiful and clover varying from good on 1 to moderate on 3. There was an even stand of rye grass on plot 4, but the clover was sparse and both erodium and cape weed were plentiful. Plot 5 was similar but with somewhat more cape weed and less erodium. The clover was fair on the control but there was a strong development of barley, brome and silver grass intermixed with erodium.

In 1944, plot 1 deteriorated, the clover being sparse and the pasture consisting mainly of dense barley grass, erodium and cape weed. Plots 2, 3 and 4 showed improvement, having less weed growth than plot 1 and the rye grass stand being satisfactory. The clover on plots 2 and 3 was somewhat uneven but good in sections and superior in this respect to plot 4. The fallow plot was still dominated by cape weed and erodium with a sparse growth of clover. The control plot closely resembled plot 1 in all respects.

Very interesting results were apparent in 1945. Although plot 1 carried a fair stand of clover, there was an abundance of barley grass and silver grass. Some cape weed was also present but a surprising feature was the low erodium content. Plot 2 was an ideal dense stand of clover and rye grass with little cape weed, erodium or extraneous grasses. The clover and rye grass on plots 3 and 4 were also very good although they contained somewhat more cape weed than plot 2. The clover on plot 5 still remained sparse, being dominated by a strong growth of cape weed. The control was again comparable with plot 1 and obviously inferior to plots 2, 3 and 4, especially the outstanding plot 2.

Only plot numbers for one series have been mentioned in the above account but the duplicate series gave similar results.

A deteriorating early subterranean clover pasture. Erodium is the main intruder.
(Photo: R. C. Rossiter.)

Observations.—Cropping with oats, along with Wimmera rye grass and subterranean clover and allowing the plot to revert to pasture the following season proved to be the most successful treatment, but the effect was not apparent immediately. Although typically stalled in 1940 there was a satisfactory stand on the control plots in 1941 and this was maintained to a greater or lesser extent, reaching the lowest ebb in 1945, the year in which the various cropping treatments, excluding the fallow, gave their best results. Under different seasonal conditions the effects may have become apparent sooner.

Croppings extending over a period of two years as represented by plots 3 and 4 eventually gave beneficial results but depressed the productivity of the pasture for a longer period without any obvious advantage so far. Fallowing proved entirely unsatisfactory and disappointing results following fallowing could only be avoided by frequent workings to reduce the cape weed to reasonable proportions. The sowing of further clover seed alone, as on plot 1, while ample remains in the soil for regeneration of the pasture did not prove advantageous.

The treatment that gives best results for one pasture may not be most effective for another, even in the same district, but the results of the Narrogin experiment and observations on farmers' properties in several districts lead to the conclusion that shallow cultivation and cropping with oats and Wimmera rye grass, is, in general, the most effective practical measure against clover stalling. This cropping can be done dry, in which case, if the pasture has not deteriorated badly, there is seldom any necessity to re-sow with clover. It is advisable not to delay the cropping until the pasture has declined to an appreciable extent, and a 4-5 year programme has much in its favour. While the soil seed content is high, even if the cropping is not done until immediately after the germinating rains, the necessity for sowing more seed seldom arises.

GRASS ESTABLISHMENT AND CULTURAL TREATMENTS.

(a) *Establishment of Grasses.*—Besides improving the nutritional level of a pasture by the introduction of suitable grasses it was felt that such non-leguminous plants could play their part in modifying the species cycle which included a marked deterioration of the sward.

In 1942 an experiment was commenced at Katanning utilising four different grasses, and having six replications of six series of plots, each plot being 1/100th acre. The sowings were as follows:—

1. Bromus carinatus ... 8 lbs. per acre + early (Dwalganup) subterranean clover 8 lbs. per acre.
2. Wimmera rye grass ... 2 lbs. per acre + early (Dwalganup) subterranean clover 8 lbs. per acre.
3. Phalaris tuberosa ... 2 lbs. per acre + early (Dwalganup) subterranean clover 8 lbs. per acre.
4. Perennial veldt grass ... 2 lbs. per acre + early (Dwalganup) subterranean clover 8 lbs. per acre.
5. Early (Dwalganup) subterranean clover 8 lbs. per acre.
6. Control (natural pastures)..

Super. was applied annually at the rate of 1 cwt. per acre. The soil consisted of a brown sandy loam originally carrying York gum, flooded gum and some wandoo. The paddock was cleared many years previously and had not been sown down to clover. Erodium was abundant.

It was intended that this experiment should be of a comprehensive nature and that estimations of yields should be made and species trends recorded. Regulated grazings were also proposed. Although later it was found impossible to maintain this programme, some useful general observations were possible.

Plant counts made at the end of July, 1942, revealed a satisfactory establishment of all sown species as shown by Table 5. The plant numbers represent the average of 60 one square link counts comprised of ten throws for each of six replications.

TABLE 5.—ESTABLISHMENT COUNTS.

	Series.						Ests. viable seeds sown per sq. link.	Per cent. established
	1.	2.	3.	4.	5.	6.		
Bromus carinatus ...	3·4	...	...	...	...	...	4·5	76
Wimmera rye grass ...	...	3·1	...	...	...	...	3·5	89
Phalaris tuberosa ...	...	...	1·5	...	...	...	4·5	33
Perennial veldt grass ...	...	...	...	1·4	...	...	3·0	47
Subterranean clover ...	3·8	3·8	3·0	3·0	3·8	...	5·3	66
Erodium botrys	1·9	1·6	1·7	1·9	2·0	1·8	...	...
Capeweed	1·4	1·4	1·0	1·2	0·7	0·6	...	...
Annual grasses	0·8	0·7	1·4	0·9	1·9	2·4	...	...

The excellent first year stand of clover was maintained and in the three subsequent seasons very good growth was made. Bromus carinatus was of slender, erect habit and showed little tendency to stool. It matured early

and did not appear to be a suitable grass for the conditions. In the year following establishment, Wimmera rye grass was sparse and was a minor component of the sward. A marked improvement was shown in 1945, however, after three seasons of clover. It was noticeable at this stage that where the rye grass was most plentiful erodium and cape weed were least conspicuous.

The perennial grasses, Phalaris and veldt also tended to reduce weed development, but unfortunately these species persisted only in sections in sufficient quantity to have an appreciable influence on the sward.

A reasonable conclusion to be drawn from this experiment is that the establishment and maintenance of a suitable grass, preferably a perennial, would do much to create botanical equilibrium in the pasture, at the same time improving the palatability and nutritional level of clover dominant swards. The difficulty, however, is to locate a species which will persist under grazing conditions in the lighter rainfall areas. Encouraging results have been secured with Phalaris and perennial veldt in the more favoured localities relative to moisture, but Wimmera rye grass remains the most widely sown species. It has the disadvantage of being an annual but is more readily established at a lower cost.

"Stalling" of subterranean clover has also been experienced in the lighter rainfall areas of South Australia where grasses have also been used as a corrective. Cook (3) reports that the field which has given the greatest trouble with cape weed at Kybybolite is the only one originally established with subterranean clover alone. No dominance by weeds such as erodium and cape weed has occurred on fields sown with grass as well as clover when efficiently managed and the proportion has varied with the seasons, the clover predominating during years of good rainfall and cold winters. Erodium has not seriously affected pastures in districts exceeding 20 inches annual rainfall but has been more plentiful in the 17—20 inch belt.

(b) *Mowing.*—With a view to ascertaining the effect of mowing on the botanical composition, experiments were carried out at Narrogin and Kojonup in 1943. The layout provided for six replications of alternative strips 25 links wide and one chain long to be mown and left uncut. The mowing was carried out on 24th September at Narrogin and 8th October at Kojonup when the clover was up to one foot high and at both sites contained erodium, cape weed and annual grasses. At Narrogin there was also a quantity of self-sown oats present. The clover had seeded down and the weeds carried immature seeds. Following mowing, the plots were raked and the hay removed.

When observations were made at the beginning of November the erodium, and to a lesser extent, cape weed had produced seeds from laterals developed following mowing. On 22nd September 1944, samples were taken to enable a botanical estimation on an air dry basis to be made. Ten grabs of approximately the same size were taken from each plot and the percentage content of each species is detailed in the Table 6. At the time of sampling the reduction in the barley grass content on the mown plots at Narrogin was very noticeable. Analyses of these figures carried out by Mr. T. N. Stoate (Conservator of Forests) showed that at the .05 level the mowing caused an increase in the cape weed content at Kojonup, but there was no significant effect on the other species. At Narrogin, however, there was an increase in the proportion of both the clover (.01 level) and the erodium (.05 level), while the grass content was reduced (.05 level). There was no significant difference due to treatment in the case of either the cape weed or oats.

TABLE 6.

EXPERIMENT 1.—KOJONUP.

—	Not Mown.							Mown.						
	Plot.						Aver-age.	Plot.						Aver-age.
	1.	4.	5.	8.	9.	12.		2.	3.	6.	7.	10.	11.	
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Subterranean Clover	43·4	54·0	47·6	41·6	49·5	40·9	46·1	56·8	49·9	53·5	52·3	32·6	46·7	48·6
Grasses	25·6	26·6	20·1	17·6	10·2	14·8	19·2	15·5	15·7	18·0	12·8	8·2	11·8	13·8
Erodium	15·9	12·9	22·1	33·8	32·2	29·1	24·3	10·4	10·0	12·0	23·8	25·4	26·0	17·8
Cape Weed	15·1	6·5	10·2	7·0	8·1	15·2	10·4	17·3	24·4	16·5	11·1	33·8	15·5	19·8
EXPERIMENT 2.—NARROGIN.														
Subterranean Clover	13·0	10·2	14·8	17·3	9·3	22·0	14·5	26·9	23·2	49·1	36·1	30·7	23·5	31·6
Grasses	70·0	27·2	27·0	65·3	74·8	49·7	52·4	15·6	30·5	20·3	8·4	40·7	24·7	23·4
Erodium	12·8	8·9	5·0	15·3	6·7	14·8	10·6	16·1	13·2	27·1	51·4	20·5	39·1	27·8
Cape Weed	·1	...	·2	1·0	9·2	13·5	4·0	...	·3	3·5	2·8	8·1	12·7	4·6
Oats	2·8	53·7	53·0	1·1	...	...	18·5	41·4	32·6	...	1·2	...	...	12·6

(c) *Phosphate Applications.*—The stalling of clover has been attributed to the effect of residual phosphates in the soil. The theory is based on the assumption that they are more readily available to weeds such as Erodium botrys than to subterranean clover and that continued applications of phosphates will increase the soil residuum and favour the weed growth.

In 1941 an experiment was commenced at Kojonup to ascertain the effects of various phosphate treatments in the form of both superphosphate and basic superphosphate on the botanical composition of an already established pasture. Treatments consisted of 2, 4 and 8 cwts. of superphosphate per acre and basic superphosphate at rates equivalent to the P_2O_5 content of the super dressings. Five replications of 1/50th acre plots were employed and topdressing at these rates was carried out in the autumn of 1941, 1942, 1943 and 1944.

Observations have been made over a period of five years and at no stage during that time has it been possible to segregate treatments by virtue of their effect on botanical composition. The control plots which received no fertilizer could usually be detected with some degree of certainty but rather due to lack of growth than any variation in species content, although latterly there was a tendency for the clover to deteriorate.

Although no quantitative estimations were made it is possible to give an impression of variation in weed content of the experimental site during 1941-45. When the initial topdressings were made in 1941 there was a good stand of clover with a moderate amount of erodium and cape weed which the following season had become conspicuously more abundant with the clover somewhat uneven. In 1943 the weed content was again at the 1941 level with a corresponding growth of clover. In 1944 a dense growth of clover contained annual grasses, mainly barley and silver grass, and cape weed as its main impurities, erodium being inconspicuous. The following year, although there was still a good stand of clover, the erodium and cape weed had again increased and the grasses had diminished.

By reference to the rainfall charts for Kojonup it will be noted that in 1942 and 1945 the first substantial rains fell in March and were followed by a comparatively dry period before the commencement of regular winter rains. In 1941, 1943 and 1944, however, there was no extended dry period following the opening rain. The first mentioned set of conditions favours the erodium to the detriment of the clover as this species germinates and makes growth with a minimum of moisture. If the moisture is sufficient to induce germination of the clover there is the risk of malting due to the dry period. On the other hand if germination does not occur, the erodium has a decided advantage when the clover seedlings appear later in the season. Erodium causes least concern when the opening rain is a sound one and is followed regularly by further falls.

DISCUSSION AND CONCLUSIONS.

The stalling of subterranean clover as experienced in the Great Southern District, cannot be attributed to any single factor. Observations over a period of five years lead to the conclusion that there are two dominant influences, firstly climate and secondly the effect of the clover and associated phosphate dressings on the soil. Both are capable of inducing a marked modification of the botanical composition of a pasture and have a decided bearing on weed competition. Other factors are also at work to a greater or lesser extent. Insects, especially red mite and lucerne flea can play their part in reducing a stand of clover and this aspect has been discussed by Norris (5). Again there is evidence to indicate a deficiency

of copper and possibly magnesium on some properties but such cases are not general. It has been suggested that magnesium increases the depth of root penetration of clover in which case any benefits from magnesium dressings could be expected in adverse seasons. Injudicious grazing can also play its part and further mention of this is made later.

Seasonal conditions affect not only the growth but the density of a clover sward and also the nature and quantity of extraneous species. A favourable growing season may be classed as one in which the opening rain is substantial and is followed by regular precipitations until late in the spring. Weed growth, is favoured by an early light fall. Erodium botrys in particular germinates with a minimum of moisture, which if insufficient to germinate the clover, gives the erodium an immediate advantage. The drought resistance of this weed is particularly high and a very severe dry period is necessary to cause a high percentage of mortality. On the other hand, if the moisture is sufficient to produce clover seedlings there is very often a high mortality rate, especially if there is a lengthy period before the commencement of the regular rains.

It has been established that drought resistance is not so much concerned with conservation of water or economy of transpiration but rather with the capacity to endure wilting unharmed. Some plants affected by drought resume normal growth following rain while others never completely recover. The degree of resumption of growth is therefore an appropriate measure of drought resistance. Using this conception of drought resistance Erodium botrys is at an appreciably higher level than subterranean clover. Pavlychenko and Harrington (6) have shown that the competitive efficiency of any species is related to the ability of the plant to develop rapidly following germination. They conclude that in competition, supremacy may be obtained by the species or variety which is able by greater physiological activity and morphological adaptability, to utilize the environment more efficiently. A better example than erodium under adverse conditions early in the season would be difficult to find.

Showing recovery of a stalled pasture in a favourable season (1942). The pegged plot has been kept free of weeds.

In 1942 and 1945 subterranean clover dominated most swards and erodium was relatively inconspicuous. Large tracts of country on which clover had not been noticed previously carried good stands. The rainfall graphs show clearly that the autumn rains in these two years conformed to the optimum requirements of the clover as already described. The low temperatures experienced during the winter of 1942 provided a deterrent for weed growth for although the clover made little growth it was not retarded to the same extent as the erodium and cape weed. This observation is supported by experiences recorded by Cook (3) at Kybybolite in South Australia. There is a ready correlation between unfavourable, intermittent autumn rains and both clover growth and species content. There are instances of large districts and even practically the entire early clover belt being affected. 1940 was a year of low rainfall and also in many districts early germinating rains in March and even January were followed by extended dry periods. These conditions were reflected in the poor stands of clover and the large areas classed as being stalled. Experimental sites selected for this very reason produced satisfactory clover pastures the following year which in most districts provided favourable conditions.

The outstanding example of a pasture at Kojonup "stalling" in the season following sowing due to practically complete malting following March rains in 1942 has already been described in detail. It is sufficient to state that the "hard" seed reserve from one season's seeding was sufficient to enable the pasture to become re-established during the following favourable seasons.

As already mentioned, the nature of the spring rains may also be of significance in determining the stand of clover the following year. Large fluctuations in clover seed yields recorded on experimental plots were directly associated with variations in the moisture content of the soil at the time of seed setting and development. No estimation, however, revealed insufficient seed to produce a moderate stand the following season and this aspect is of less importance than the destruction of seedlings due to malting. Weeds such as erodium, mature earlier and their seed setting is unlikely to be affected by a dry spring.

Closely linked with the climatic factor is the effect of the clover growth and associated phosphate dressings on the nitrogen content of the soil and in consequence, the botanical composition of the pasture. Although chemical analyses of a limited number of soil samples taken during this investigation have not disclosed any definite correlation between soil nitrogen status and "stalling" there is ample evidence from a number of sources to show that the nitrogen level is increased by the application of phosphate in association with grazing. This applies to natural pastures as well as developed subterranean clover pastures although more accentuated in the latter case. In South Australia (4) under rainfall conditions similar to those existing in the early clover belt of this State, the nitrogen content of the top four inches of soil was nearly doubled by regular phosphate dressings on natural pasture over a period of twenty years. Such natural pasture could be expected to contain an appreciable proportion of volunteer legumes.

Top dressing with superphosphate, therefore, besides stimulating the growth and multiplication of clover and weeds due to the available phosphate, increases the fertility of the soil mainly by stimulating the activity of nitrogen fixing bacteria associated with legumes. This increased nitrogen content due to symbiotic action creates a condition which favours non-legumes to the

detriment of the clover and in consequence has a strong influence on the composition of the pasture which passes through a botanical cycle modified however, by other factors, especially the climate. This cycle includes, as the two extremes, pastures of pure subterranean clover and those dominated by non-leguminous species of which Erodium botrys, cape weed and grasses are the major components.

It is reasonable to expect that the higher the rate of phosphate application (within reason) the greater the tempo of these processes will be and the sooner the cycle is likely to reach the stage where the clover is dominated by weeds. Regular observations from the time of the initial sowing of plots receiving varying phosphate applications have shown this assumption to be correct although when a pasture has been established for a number of years and has reached a climax, even though an unstable one, the quantity of phosphate applied does not appear to be an important factor in determining botanical composition.

When the weed phase of the cycle is reached the climatic factor already discussed assumes maximum proportions and the balance inclined in favour of the weeds can be completely tilted by certain seasonal features. The clover element of a pasture can be very sorely depleted by malting under low soil moisture conditions even when weeds are not prevalent. The risk of stalling increases, however, as the clover and associated weed growth becomes more dense and the competition, especially for moisture more intense. A number of examples have been noted of scattered clover plants experiencing little competition from their own or other species remaining green considerably longer than nearby crowded plants. Experiments conducted by Ashby and May (1) in New South Wales indicated that a high level of nitrogen, possibly through its effect on the growth rate, renders the Fulghum variety of oat more susceptible to the harmful effects of drought. The dry conditions were not only reflected in the number of plants killed, but also in the effect on subsequent growth of plants that survived. This may represent another influencing factor although there is no information regarding any variation in the reaction of different species.

Although the question has already been answered in an indirect way, it is reasonable to ask, as the climatic factor is considered of such importance, why do pastures usually stall after they have been established for say five or six years. We have the example, already discussed, of a pasture at Kojonup established on old land stalling the year following sowing but it is more usual for the trouble to occur after a number of years, for during that period the pasture normally passes through the phase of the cycle which creates conditions favourable to weed growth and renders the clover more susceptible to the vagaries of the season. As mentioned previously, the vulnerable period is reached more rapidly with higher phosphate applications but this does not necessarily provide argument for reduced super. dressings. Within practical limits the pasture yield is dependent on the amount of phosphate available and if the application rate is reduced the carrying capacity of the pasture will be affected.

When consideration is given to the many factors, large and small, influencing the growth of subterranean clover in the low rainfall belt, unhindered development of this species cannot be expected. The main weed competitor, Erodium botrys, is more drought resistant and has a shorter growing period than Dwalganup subterranean clover. When the length and continuity of the season meets the requirements of the clover as is usually the case in the western portion of the early belt, stalling in its acute sense is not experienced and any reduction in the clover content of a sward is repaired by cropping. When such seasonal conditions

do not apply, obviously they conform closer to the requirements of such weeds as erodium and it is only natural for these weeds to assert themselves under such circumstances.

A pure stand of subterranean clover is far from being an ideal pasture and there is an immediate need of a suitable grass to improve the nutritive level of pastures in the Great Southern District. Besides increasing their value for stock, experiments conducted at Katanning have shown that grasses play an important part in reducing the proportion of weeds. Perennials are most effective in this respect but Wimmera rye grass was also found useful. As some difficulty is experienced in establishing and maintaining such grasses as Phalaris tuberosa and perennial veldt grass over extensive areas in the early clover district, Wimmera rye grass would appear to be the most suitable species to employ until further agrostological advances are made. The incorporation of a palatable and nutritious grass is equivalent to replacing a proportion of the non-leguminous species of a pasture with a more useful component which also assists in maintaining the clover proportion at a satisfactory level.

Experiments conducted at Narrogin and the experience of some farmers have shown that pastures tending to deteriorate can be revitalised by cropping. Deep ploughing is inadvisable and satisfactory results have been achieved by making a dry shallow sowing of oats, preferably with Wimmera rye grass, using a combine. The surface scarification improves the soil texture for the growth of the clover and also allows greater advantage to be taken of any early rains. If sowing cannot be carried out dry, it should not be long delayed after the germinating rains or a big loss of clover seedlings will result. Early rains sufficient to germinate erodium with little clover or if the clover malts leaving the weeds, provide excellent opportunities to check the erodium and, at the same time sow a crop if desired. By cutting for hay and removing the crop, theoretically at least, the soil nitrogen level is decreased but improved clover stands have resulted following cropping and grazing. Some farmers have successfully adopted a four year rotation consisting of pasture for three years and a crop in the fourth. Field experience and evidence from some experimental plots indicate that surface working of the soil even without cropping, prior to or immediately following the first germinating rains, benefits the clover. An increase in vigour has been observed following the gathering of seed, especially from old pastures. Seed harvesting entails surface working of the soil to "lift" the burrs and this cultivation can be, at least, an indirect factor. Some farmers favour the use of a combine or drill in preference to a broadcaster in order to scarify the surface of the soil when applying the superphosphate dressing. There is scope for further investigational work in this direction, particularly with reference to the most satisfactory cropping programme. This may be found to vary for different districts.

Cape weed has been reduced by heavy grazing for short periods, especially at the flowering stage, although paddocks are usually too large to secure maximum results. Stock are not a satisfactory agency for suppressing erodium as it is not eaten readily, especially when nearing maturity. For this reason excessive grazing can actually be detrimental to a pasture in which erodium is abundant and clovers represent a palatable minority. Stock then tend to further reduce the clover to the advantage of the less palatable weeds which they avoid. Mowing has caused a reduction in the grass content the following year but does not appear to have any lasting remedial effect on a deteriorated pasture.

ACKNOWLEDGMENTS.

I wish to acknowledge the support and assistance of Mr. G. K. Baron Hay (Under Secretary for Agriculture) and Dr. L. J. H. Teakle (Plant Nutrition Officer), Mr. I. Thomas (Superintendent of Wheat Farming) and Mr. M. Cullity (Superintendent of Dairying) who comprise the committee associated with this investigation. Also other fellow officers of the Department of Agriculture, especially Mr. A. S. Wild who was co-worker in the earlier stages and Miss M. Dolley, who assisted with the seed estimations and preparation of graphs. The copying of graphs and charts was undertaken by Mr. P. Stanley, Chief Draftsman, Lands Department, to whom I am indebted.

Thanks are also due to the many farmers who provided information and practical suggestions concerning the problem when a general survey was being carried out, especially those who made areas available for experimental work and rendered assistance, at times, at considerable inconvenience to themselves. I will be excused for not listing them individually as many farmers were concerned.

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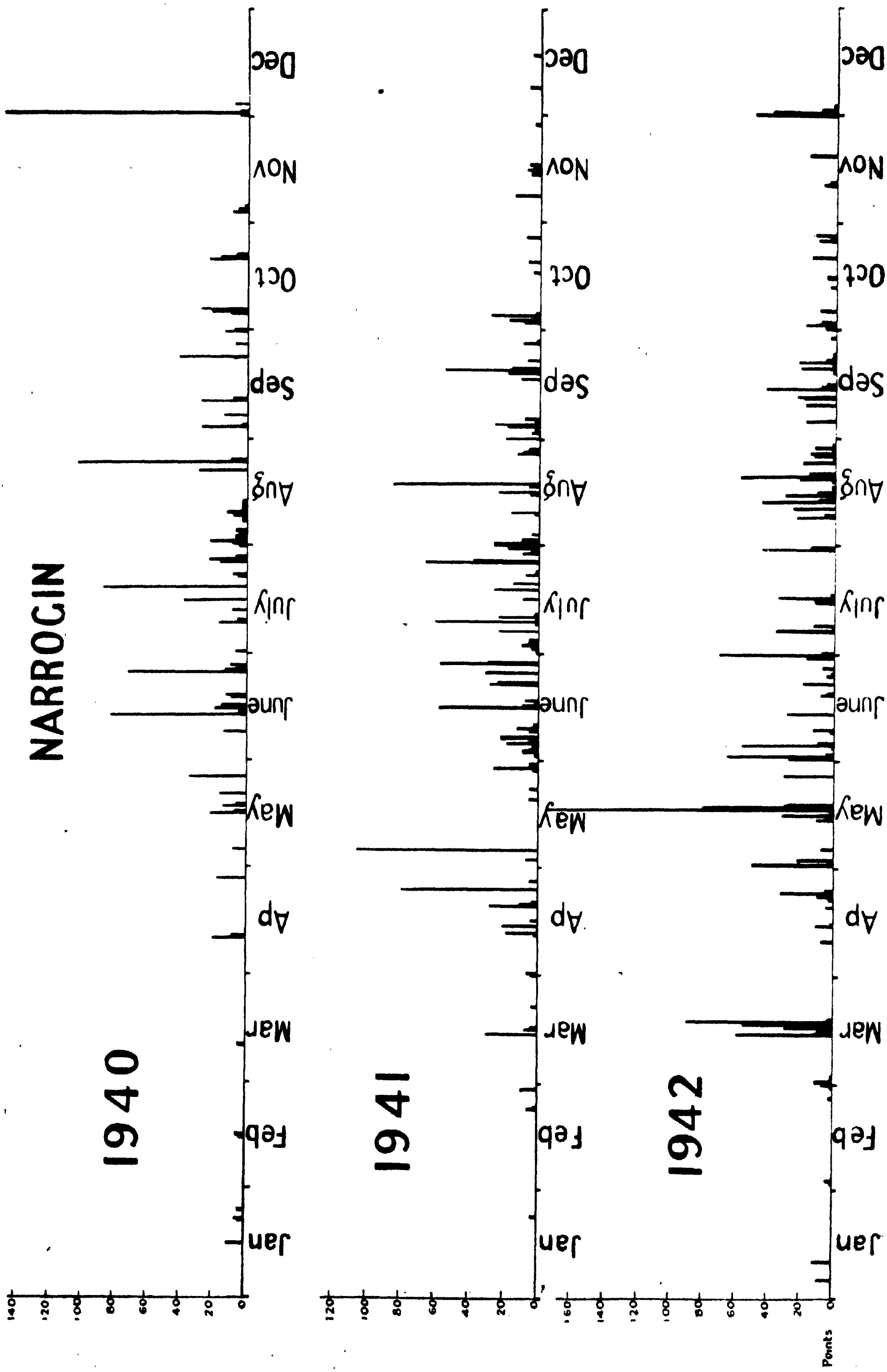
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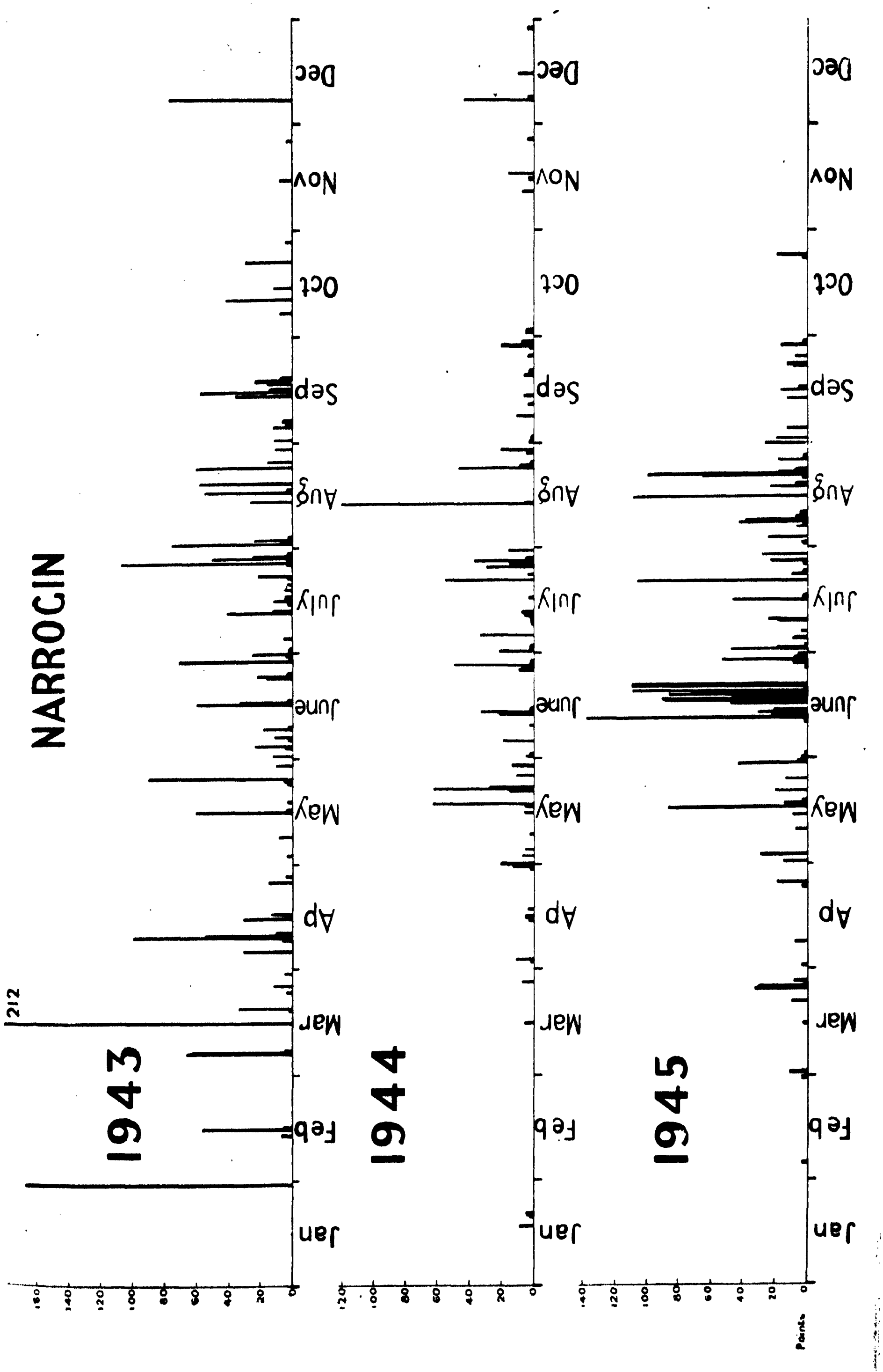
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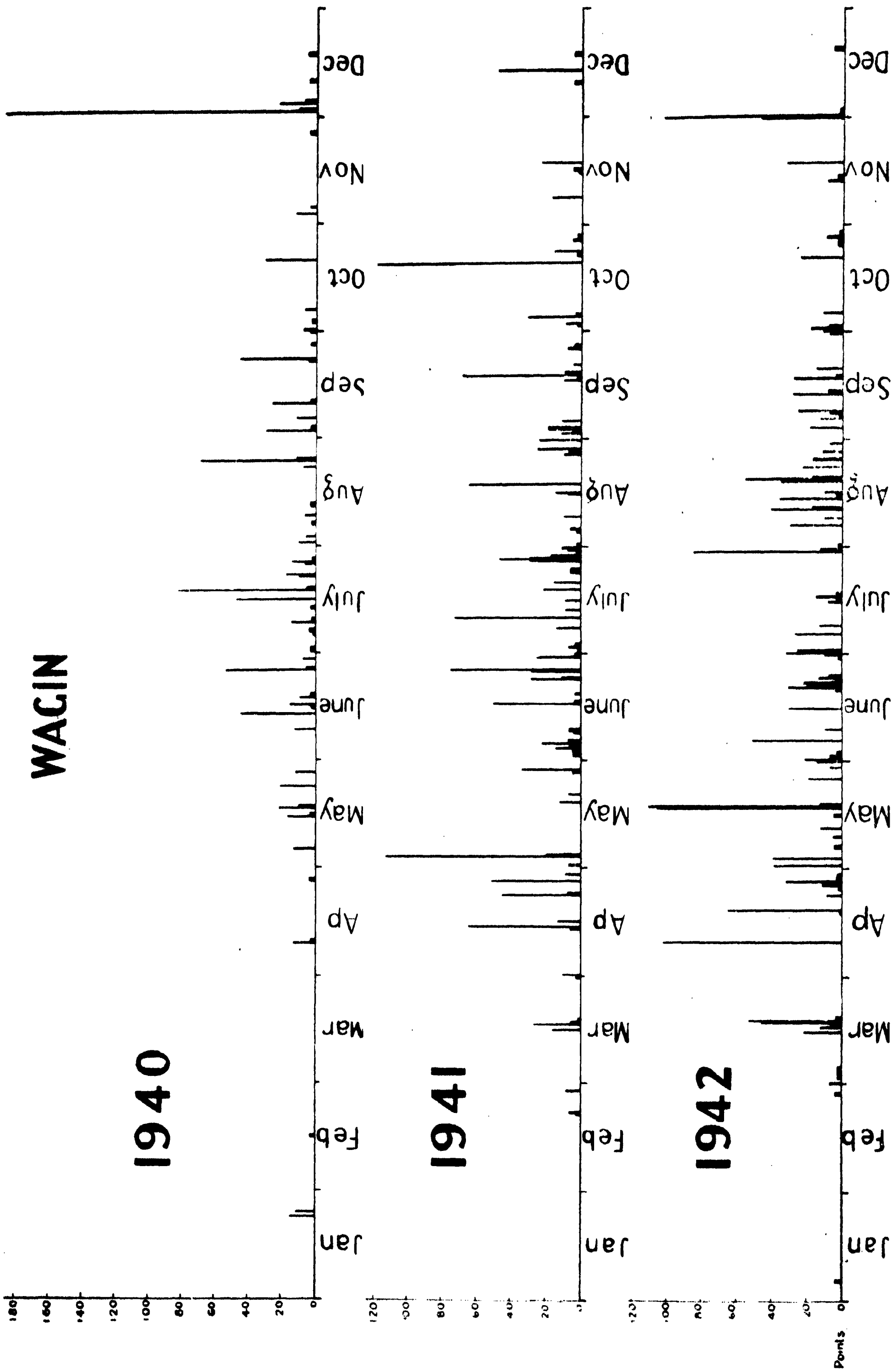
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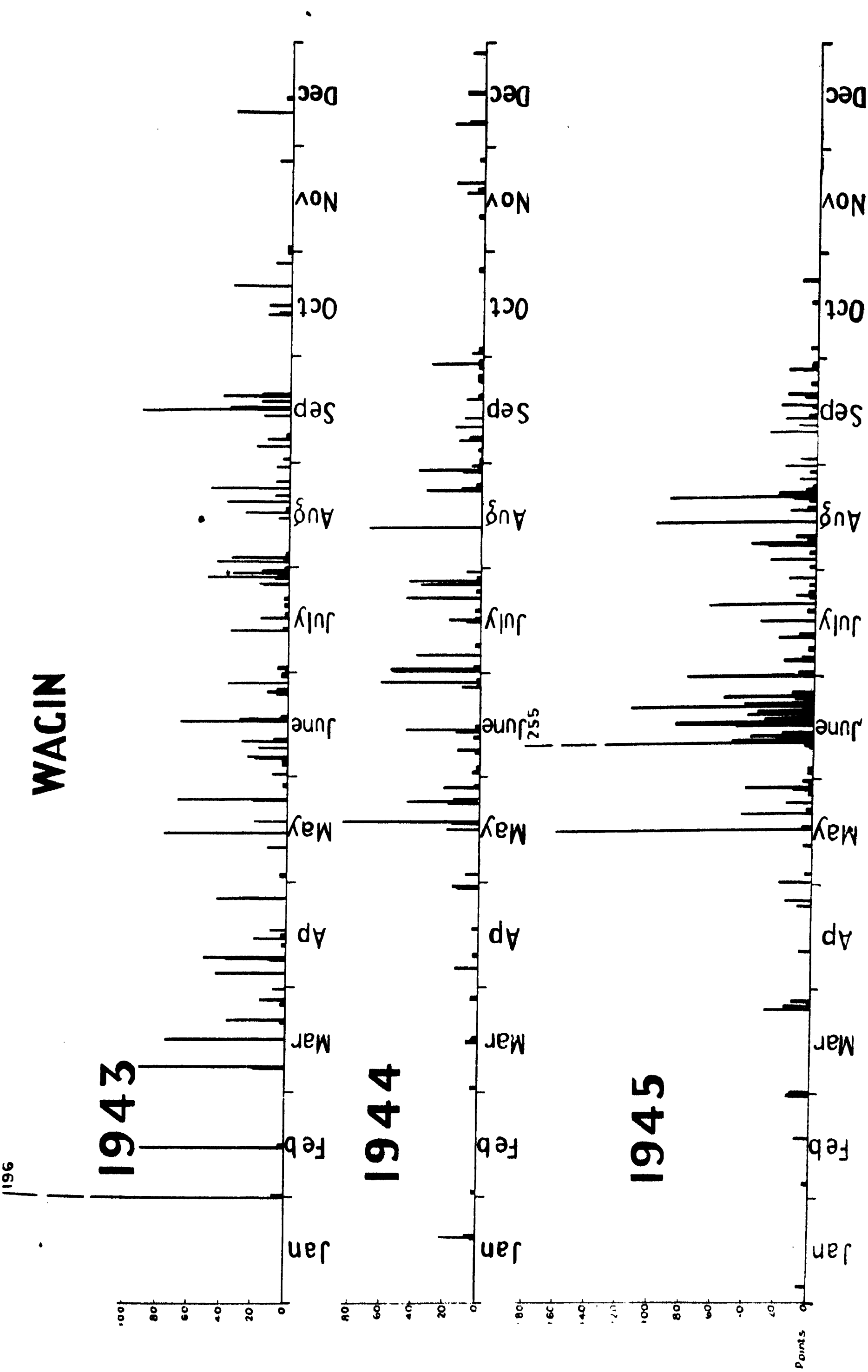
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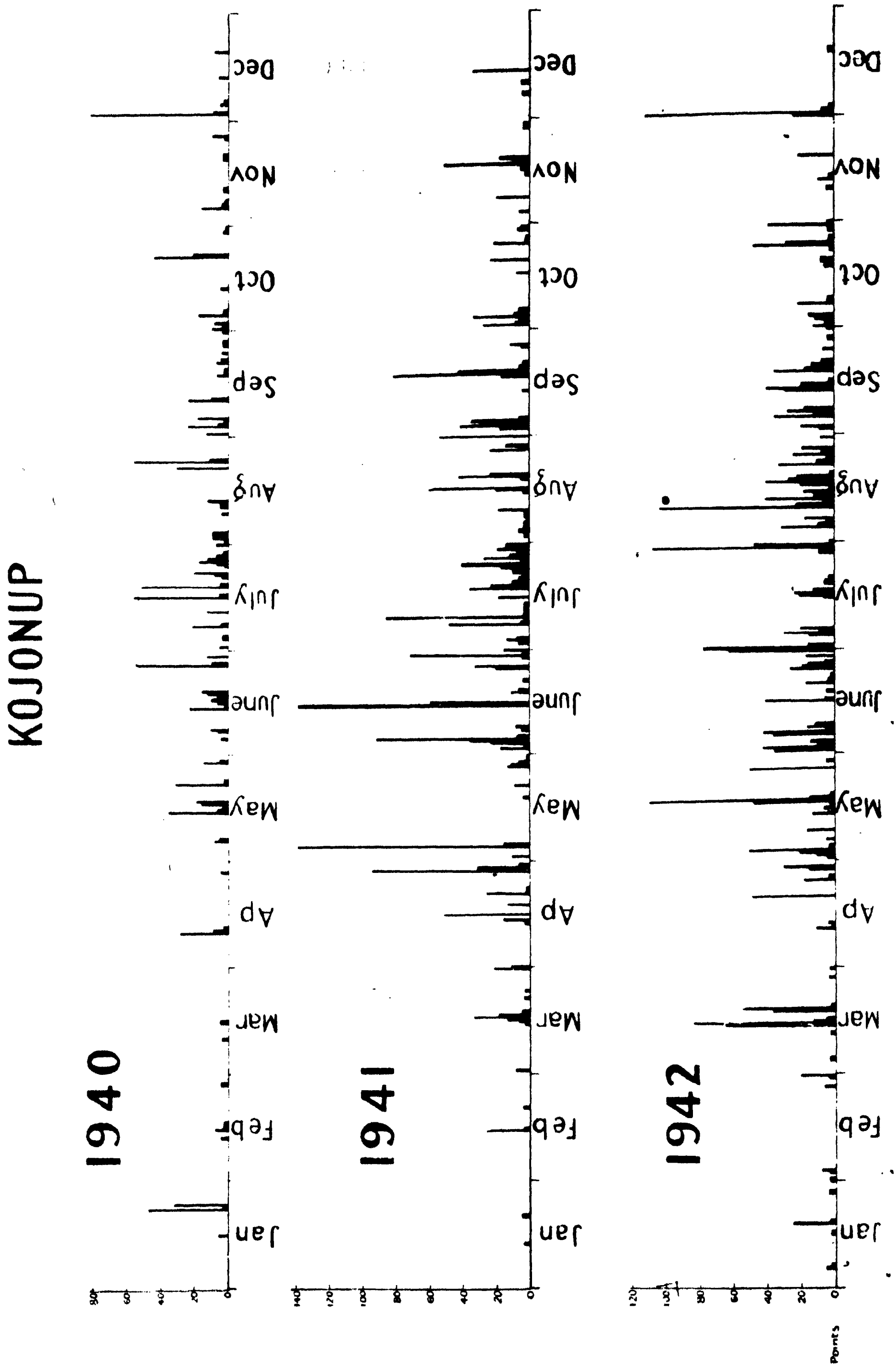
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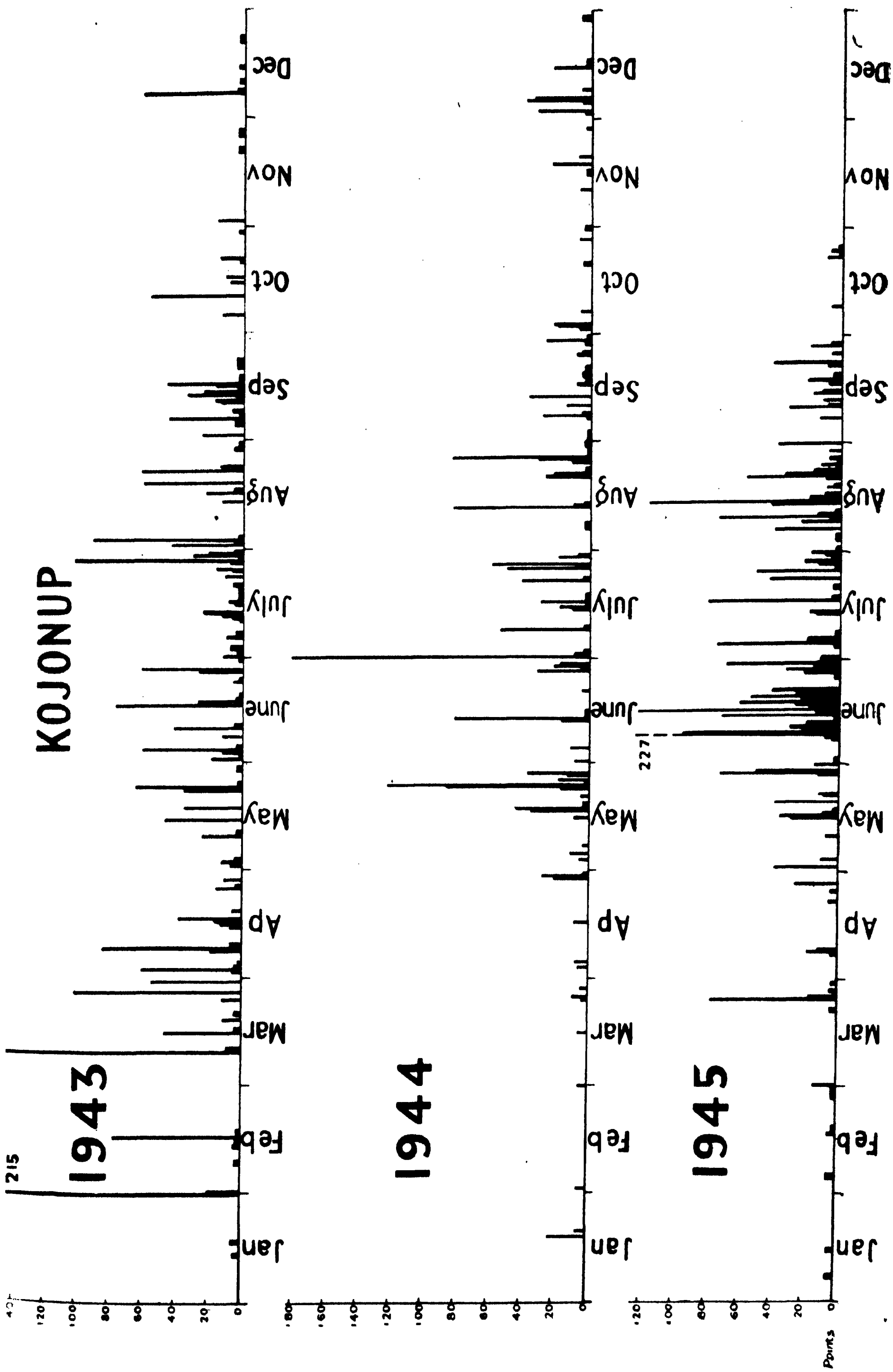
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Cobaltised Superphosphate.

A CORRECTION.

By L. J. H. TEAKLE.

IN drawing attention to the cobaltised superphosphate in the control of cobalt deficiency disorders of stock in the December, 1945, number of this *Journal*, page 304, it was stated—

> "It is of interest that the discovery of cobalt deficiency as the cause of a stock ailment was made in Western Australia."

It is regretted that reference was not made to the work in the laboratory of the Division of Animal Health and Nutrition (now the Division of Biochemistry and General Nutrition) of the C.S.I.R., in which the initial discovery of cobalt as a factor in animal nutrition was made. Mr. H. R. Marston, chief of this division, has pointed out that the discovery of cobalt as an active agent in curing and preventing a stock ailment was made in his laboratory by Lines, in 1934. This was reported by Marston (1935) and Lines (1935). In this instance, cobalt was used in the investigation of "coasty" disease, which is now known to be due to a deficiency of both cobalt and copper. It was on account of this dual deficiency that "coasty" disease was not referred to in the note recommending the use of cobaltised superphosphate in Western Australia for areas where the Denmark wasting disease is liable to occur.

Denmark wasting disease of Western Australia is apparently related solely to cobalt deficiency. There is no evidence of any other element, such as copper, being directly involved. The discovery of cobalt as the biologically potent element in the control of wasting disease was made in Western Australia by Underwood and Filmer (1935), a few months after the finding of the importance of cobalt as one of the factors in "coasty" disease by Lines.

It is of interest that 28 tons of cobaltised superphosphate have been sold in Western Australia in 1946 to date. The success of this fertiliser in New Zealand warrants an extension of its use in this State.

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"Wither Tip" of Apple Trees.

By T. C. DUNNE, Horticultural Research Officer.

IN 1938 there were reported the results of an investigation into the disease of apple trees known as "wither tip" or "summer dieback." It was shown at that time, that the condition resulted from a deficiency of copper for the normal growth of trees. It was also demonstrated that satisfactory growth could be obtained by applying copper sulphate (bluestone) to the soil around the trees or temporarily, by spraying in late November or early December, with Bordeaux mixture.

For much of the time during the intervening years, copper salts have been in short supply. In addition, many orchards have, of necessity, not had the attention which would ordinarily have been given. As a result, there are, in some districts, many trees to be seen which show evidence of copper deficiency.

Where treatment of diseased trees has been undertaken the results have been very gratifying. It is, therefore, considered advisable to draw the attention of orchardists to the benefit to be derived by making good such deficiencies.

By way of review, the following extract which concerns symptoms, is taken from the original article—

> "Badly diseased trees are usually characterised by a stunted bushy growth habit due to inability to develop a leader system.
>
> "The disease usually develops on vigorously growing shoots. During November or December, brown spots appear on the terminal leaves. Small necrotic areas are next noted. Leaves developed thereafter are more severely affected and eventually wither and fall. This condition is followed by the withering and death of the upper portion of the shoot where three to twelve inches of growth may be affected."

A typical case of "wither tip" is shown in Fig. 1.

Fig. 1.

The application of copper may be made in a number of ways, some of which are more effective than others. These include:—

(a) Spraying with Bordeaux mixture in November or December. This method gives almost immediate response, but the effect may only last for the one season. A 3:4:40 mixture is effective.

(b) Spraying with Bordeaux mixture during the dormant period. Satisfactory responses have been obtained in some cases by this method. A strength of at least 6:4:40 should be used.

(c) Application of copper containing compounds to the soil. This method is quite effective though the response may not be obtained the first season following application . The material should be applied to the soil in August in a band a`out three feet from the trunk in the case of small trees, or at about the drip ring in the case of larger trees. For quicker results the application should be dug in about spade depth.

Copper sulphate has been used in all experiments at the rates of 1 lb. for a small tree and 2 lb. for a larger one. However, the results secured by departmental officers using copper containing ores on other crops, indicate that such ores could be successfully used.

(d) Combination of soil application and spraying. Where trees are badly affected, both soil application and spraying are recommended for quick recovery. The soil application made in August would be followed by a spraying in early summer. Such treatment may last for many years or may even supply such stimulus that further treatent is not needed.

The benefit to be obtained for supplying copper in deficient areas has been well illustrated by the results obtained in a Young's Siding orchard. At the time the applications were made the trees were seven or eight years old and the effect of the deficiency in restricting growth is shown by the Figs. 2a and 2b, of two trees taken at that time (1940).

Fig. 2a.—Yates, 1940.

Fig. 2b.—Dunn's Seedling, 1940.

Copper treatments (soil and spraying) were continued on these trees, partly to determine whether copper poisoning would develop. At the end of four years, it was deemed advisable to discontinue applications. However, Figs. 3a and 3b, taken in 1945, clearly illustrate the improvement which has been achieved.

Fig. 3a.—Yates, 1945.

Fig. 3b.—Dunn's Seedling, 1945.

In addition to the above, a number of unthrifty trees which were not showing severe "wither tip" symptoms have since been given treatment with copper by the owner. These trees have shown excellent response and there is every prospect that a satisfactory orchard will be obtained from trees which, at one stage, were anything but promising.

Manganese Deficiency of Apple Trees.

By T. C. DUNNE, Horticultural Research Officer and A. T. GULVIN, Horticultural Instructor.

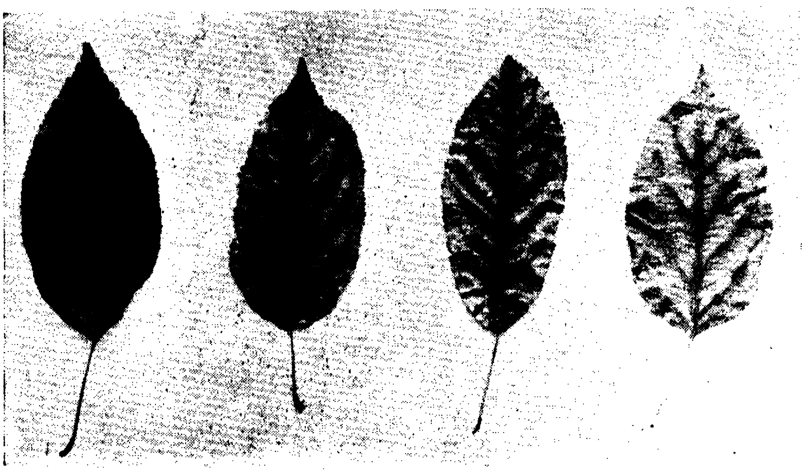
A FEW years ago an investigation was begun of a diseased condition of apple trees in an orchard in the Albany district, and of a similar one in an orchard in the Mt. Barker district. As a result of tests in which various substances were applied to the trees by means of limb injections, both solid and liquid, by sprays and by soil applications, it was proved that the trouble was due in both cases to an insufficiency of manganese for normal growth. Numerous leaf samples have been analysed including those from healthy and unthrifty trees, from trees supplied with manganese and from others not so treated, in order to determine for this element, the leaf contents essential to healthy growth.

It has not only been found that manganese deficiency exists in a number of districts but also that, in some areas, the incidence of the disease is increasing. Furthermore, although it is possible to bring about a fairly rapid cure for some

aspects of the disease, it is not easy to stimulate new growth in trees which have suffered from deficiency for a number of years. For this reason, it is strongly recommended that attention be given as soon as it becomes certain that a deficiency exists.

SYMPTOMS OF MANGANESE DEFICIENCY.

The effect of deficiency of manganese in apple trees is most readily recognised by inspection of the leaves. In the illustration below, a normal leaf from a Dunn's Seedling tree is compared with leaves from trees of the same variety showing various degrees of deficiency.



1. 2. 3. 4.

Fig. 1.

The leaf marked 2 in the illustration shows the type of leaf symptom obtained when the disease is not very severe. If half or more of the leaves on the tree are so affected, immediate attention is warranted. In more severe cases, the green colouring of the leaf remains only along the main veins as is illustrated by leaf 3. The other leaf 4 illustrates the condition of acute deficiency when very little green colouration is found. Such leaves are usually very thin, are easily bruised by the wind or by handling, and often develop scorched edges.

The effect of deficiency on the trees is shown by a general stoppage of growth. The foliage is often sparse which is partly due to a reduction in the number of fruit spurs, a condition which is characteristic of the disease. This, of course, is usually followed by a small fruit crop the following year—deficient trees yield poorly.

The fruit itself may be affected. In the cooler districts Dunn's Seedling apples often develop some red colour but this may be accentuated by manganese deficiency. With varieties such as Yates, which may set a heavy crop on the existing spurs, the fruit from affected trees is sometimes appreciably reduced in size probably due to the lessened carbohydrate (e.g. sugar) formation consequent upon the lack of chlorophyll in parts of the leaves.

INCIDENCE OF THE DISEASE.

There is no doubt that the severity of the disease varies with seasonal conditions. Trees which in a good rainfall season show little or no sign of deficiency are markedly affected during a dry summer. Similarly, under such dry conditions, trees which normally are only slightly affected develop all the symptoms of acute deficiency. For this reason, symptoms have been noted during the past three seasons in those areas where the less than normal rainfall has had most effect in other ways. In this connection, it is believed that the reduction in the soil moisture seriously reduces the availability of manganese to the trees.

As mentioned above, deficiency symptoms have been noted in a number of apple growing areas. At Kendenup, which has a lower annual rainfall than most other apple districts, the disease has become rather widespread. Trees showing deficiency, in some cases acute, have also been found in the King and Kalgan River areas, at Mt. Barker, at Denmark, at Donnybrook and in the hills east of Perth.

There is some variation in the soil types with which manganese deficiency is related, but usually they are gravelly or gritty loams underlain by clay at shallow depths. Conditions appear to be worst where light or very gravelly surface soils are encountered.

TREATMENTS AND RESPONSES.

Of the treatments tested to date, the most effective in securing quick response is that of spraying the leaves with manganese during November or early December. For this purpose a "manganese burgundy mixture" has been used. The mixture consists of 4 lb. of manganese sulphate and 4 lb. of washing soda to 40 gallons of water. It is in no way harmful and if the leaves are thoroughly wetted, a healthy green colour will be obtained during the season of application.

On no account should lime be used as a substiute for washing soda, nor should lime containing spreaders be used. The use of lime with manganese results in the formation of an insoluble compound which is ineffective for the purpose in mind.

Soil applications of manganese sulphate have also given satisfactory results but may not take effect the first season following application. A good deal of the manganese applied is apparently fixed by the soil—at the least some of it is rendered temporarily unavailable. In England, it is reported that trees failed to respond to soil applications and this method is not recommended there, but in this State it has been used quite successfully. It is recommended that 2-4 lb. of manganese sulphate per tree, depending on its size, be applied in August in a band 12-18 inchs wide at about the drip ring of the tree. Favourable response would be hastened if the material were dug in to spade depth.

Where possible, and with trees showing acute deficiency, the soil application in August, followed by the spray in the early summer, should repay the cost and labour involved.

The benefits of treatments are demonstrated in the illustrations below showing Dunn's Seedling trees at King River. Figure A shows an affected tree with lack of growth and sparse foliage. From this tree about one bushel of fruit was picked. The next figure (B) illustrates the effect of soil treatment with manganese sulphate on a nearby comparable tree from which over four bushels of fruit were obtained. The other figure (C) of a larger tree shows the response to spraying with "manganese burgundy" and from that tree over eight bushels of fruit were picked. The

photographs were taken early in 1944, about three and a half years after the first soil application was made.

A.—Control. No treatment.

B.—Soil treatment with manganese.

C.—Spray treatment with manganese.

DIAGNOSIS OF MANGANESE DEFICIENCY.

A grower may be able to decide whether or not his trees are suffering from insufficient supplies of manganese by comparing leaves from suspected trees with the illustration (Fig. 1) of the symptoms. A little intervenal yellowing on a few shaded leaves at the bottom of the tree need not be regarded seriously as such leaves can often be found on trees not appreciably affected. If, however, a large proportion of the leaves show the symptoms, the Horticultural Adviser for the district should be consulted for further advice.

Manganese deficient leaves showing intervenal yellowing are usually of normal size and should not be confused with the small partially yellowed leaves which appear on "dieback" shoots on many trees. Such small leaves are not necessarily associated with manganese deficiency at all.

Sufficient data have been accumulated to allow of interpretation of most leaf analyses for manganese. When deemed necessary by the horticultural officer, leaves of suspected trees can be forwarded by him to Perth, where confirmatory diagnosis based on leaf analyses can be made.

Selecting Vegetables For Seed Production.

T. C. DUNNE, Horticultural Research Officer.

IT is almost impossible to over-emphasize the value of good seed to the grower of vegetables. The production of any intensive vegetable crop entails so much expenditure by way of labour and manures that it is foolhardy to begin with anything but the best available material. Usually the cost of good seed represents only a small proportion of production costs and a lesser quantity of it is needed to ensure sufficient vigorous plants than if poorer quality stock is used. Nevertheless, there are still a number of growers who are content to risk crop failure by the use of seed of mixed or at least doubtful parentage.

For a period during the war years, producers had to contend with the vagaries of seed which in many cases was of poor quality. This was occasioned by losses en route of overseas consignments and the necessity for replacing them with stocks available in a world already suffering from shortage of supplies. At the present time however good quality seed is available, much of it grown in Australia.

Curiously enough, many people still have a prejudice against Australian grown seed. This is hard to understand, particularly in this State where the commercial production of carrots, onions, tomatoes, runner beans and cauliflowers depends to a great extent upon locally grown seed of varieties which were developed within the State.

There are growers, who though normally users of good seed, nevertheless prefer to produce their own seed stocks wherever this is possible. Providing sufficient care is taken this can be well worthwhile. It is well known that many vegetables are particularly responsive to relatively small variations in environmental conditions including climate. For this reason, the nearer the climatic conditions under which a vegetable variety is developed to that where it is intended it shall be grown, the more likelihood there is of obtaining regularly successful crops.

If a beginning is made with vegetables of reasonable quality it is often surprising how quickly improvement can be brought about by intelligent selection. As a guide to those interested growers who are willing to give the necessary attention to seed production, a few reminders for the selection of vegetables for this purpose are given below. Only those vegetables have been dealt with in connection with which improvement might be most easily effected.

CABBAGE.

Select cabbages of the actual size and shape desired but select them all at the one time. If plants are selected over a prolonged period from the same crop, a line of seed is likely to be developed which will show considerable variation in the time taken by the cabbages to mature. Strictly avoid any plants showing signs of disease.

For the initiation of flowering exposure to cooler weather than normally occurs in the metropolitan vegetable growing area is needed. Where the climate is too warm, successful results may be obtained by placing either the stumps or the complete cabbages in cool store (about 8 weeks at 40°F.). Under such conditions, the heads may rot badly but this does not prevent seed production. Transplanting may be done from June to August.

CARROT.

Carrots should be selected for size, good colour, a small, well coloured core, good internal texture, and for flavour. The internal factors can be gauged by cutting about one inch from the bottom of the root. This does not interfere with subsequent growth and may be an advantage when replanting long roots.

In this State, the local varieties show resistance to carrot virus disease but some plants may be affected. For this reason avoid any carrots showing yellowing or malformation of the tops.

Transplanting is done during July and August.

ONIONS.

A large number of growers produce their own onion seed and generally high yielding lines of the both white and brown types of Spearwood Globe are to be found. Many onions however are not inherently good keepers and improvement in this respect is needed. Select, from the longest keeping onions, those bulbs satisfactory with respect to size and shape which have the largest number of thick skin layers. Bulbs may be planted out from May onwards.

TOMATOES.

The early and late Wanneroo types generally grown locally have good colour, flavour and carrying capacity. In many cases however the proportion of solid pulp is too small. Do not select individual tomatoes but select from those individual bushes, the fruits of which when cut across, show plenty of pulp without having a hard core. Such fruits will yield smaller quantities of seed but a quality line will result.

BEANS.

Dwarf—

Yields of dwarf beans are too often reduced by mosaic disease which not only is transmitted from plant to plant but which is also carried in the seed. In the seed plot consistently pull out all plants showing any sign of mosaic and then select from the remaining individual plants.

It has been found with beans, both dwarf and runner, that mosaic symptoms may be masked in hot weather. To ensure all diseased plants being recognised it is advisable to get early growth during the cooler months such as occur in the spring.

Runner—

With runner beans, too, mosaic is an important yield reducing factor and its elimination must be thorough. In the seed plot staking each plant separately will help in eliminating disease and in selecting these individual plants with high yielding qualities. Make sure than the beans are well shaped and true to type.

MANURING.

For seed from tomatoes and beans the normal manuring for these crops will be done as a matter of course. For seeding cabbage, carrot, and onion, liberal manuring is needed for, although certain reserves are stored in the stalk, root, or bulb as the case may be, these are mainly carbohydrates. Nitrogen, phosphate and in some cases potash are needed to induce vigorous seed plants which are prerequisites to good crops of healthy seed.

GENERAL.

No selection, however good, will produce results if care is not taken to avoid cross pollination. A list of plants polinating each other has been published previously in this *Journal* (September 1943). A grower should ensure that his selected plants are placed at least ten chains and preferably further from any source of contamination.

Never save seed from cabbages, carrots or onions which have seeded in the vegetable plot of their own volition. By doing so, lines are being propagated which have a tendency to bolt.

It is most inadvisable to collect seeds of beans or tomatoes after the bulk of the crop has been harvested. If this is done, most of the seed will be obtained from the late maturing plants and from plants which produced material unsuitable for market. Collecting seed in such manner ensures a steady decrease in quality from year to year.

Briefly, in selecting vegetables for seed, avoid disease, select uniformly for uniformity, select the best and keep it pure.

Classing the Clip for Auction.

W. L. McGarry, Sheep and Wool Adviser.

With the termination of the appraisement scheme and a reversion to the auction system of wool selling during the 1946-47 season some modification of classing becomes necessary in order to ensure maximum returns.

Under the appraisement scheme every lot of wool whether one bale or more received its full appraisement value but under auction conditions previous experience has indicated that the larger the lot the more competition enjoyed.

Under the auction system the quantity of wool in an offered line (quite apart from the quality) is an important factor in its ultimate value under the hammer.

The preference of the buyer for big lines is reflected in the final bid and it is necessary for the grower to remember this when classing and make as big lines as possible.

Small lots of under four bales are known as "Star" lots. These small lots are sold separately from the "Big" lots (four bales and over) which receive more careful examination and enjoy keener competition than the "Stars."

When classing it is important to remember that a high *average* price per pound is more important and means better returns than where one or two bales of picked fleeces are made into a top line and bring a high price. The quantity and value of the top lines is increased with the blending of these one or two bales of picked fleeces through the top lots. A high *average* price is a most important factor from the viewpoint of *actual cash returns* and the aim should therefore be to make top lines as large as possible.

There has been a definite tendency to overclass many clips under the appraisement scheme and the classing out of many one and two bale lines will not prove profitable under the auction system of selling.

It is unnecessary and unprofitable for farmers to endeavour to "sort" their wool. "Woolclassing" only calls for matching whereas sorting of wool can only be done correctly by the trained sorter.

In order to secure the maximum benefits from classing under the auction system of wool selling it is essential to:—

(1) Make as big and as few lines as the number of sheep being shorn will permit.

(2) Keep tender fleeces out of sound lines.

(3) Keep separate any irregular fleeces which do not match with any of the standard lines. These should be placed in bags or mixed bales. Evenness in length is more important than quality (fibre diameter) in Merino Wool.

(4) Skirt fleeces properly. Hard and fast rules cannot be laid down owing to variable seasonal conditions and the degree of skirting must be left to the classer's discretion. Do not overskirt. Heavy skirting, if not warranted, is unprofitable.

(5) Black tipped, fatty, rough or daggy, and rams fleeces should be kept separate.

(6) Do not sex brand on bales, but advise broker of bale numbers of each sex.

The following descriptions are applicable to agricultural and southern clips. It must be remembered, however, that because a description is shown, it does not necessarily follow that every clip has wool to fit this description and it can therefore be eliminated.

SUGGESTED LINES FOR THE CLASSING OF MERINO FLOCKS OF UP TO 500 SHEEP.

AAA COM	Longest, lightest and brightest.
AA COM	Shorter, heavier and less attractive. All out sorts (rough, very fatty, very tender and rams) to be put into bags or mixed bales.
AA PCS	One line, stains removed.
AA BLS	One line, stains removed.
STD PCS	
LKS	
AAA LAMBS	Longest.
AA LAMBS	Shorter.

FLOCKS OF 500-1000 SHEEP AND OVER.

AAA COM	Sound, good length, light condition (fine to medium quality).
AA COM	Sound, Shorter, heavier (fine to medium quality).
BBB	Sound, good length, light to medium condition, strong quality.
AAA FLC	Average length, fine to medium, tender.
AA PCS	Pieces, stains removed.
AA BLS	One line, stains removed.

STD PCS	One line, dags removed.
LKS	One line, dags removed.
AAA LBS	Longest, stains removed.
AA LBS	Shorter, stains removed.

In larger clips extra lines may be made where warranted.

COMEBACK AND CROSSBRED FLOCKS OF UP TO 500 SHEEP.

AAA CBK *or* AAA XB	Finest to medium quality.
AA CBK *or* AA XB	Medium to strong quality (outsorts, such as cotty, discoloured and faulty fleeces to be kept separate).
AA PCS	One line, with stains removed.
AA BLS	One line, with stains removed.
STD PCS LKS	
CBK LBS	Fine quality, stains removed.
XB LBS	Medium to strong quality, stains removed.

COMEBACK AND CROSSBRED FLOCKS OF UP TO 500 SHEEP.

AAA CBK *or* AAA XB	Good length, light to medium condition. Fine quality.
AA CBK *or* AA XB	Good length, light to medium condition, medium quality.
A CBK *or* A XB	Shorter, heavier, fine and medium quality.
AAA CBK FLC *or* AAA XB FLC	All tender fleeces.
XB	All very strong quality fleeces (all cotty, discoloured and very rough fleeces into bags).
AA PCS	One line, stains removed.
AA BLS	One line, stains removed.
STD PCS	One line, dags removed.
LKS	One line, dags removed.
CBK LBS	Fine.
XBD LBS	Medium to strong (short lambs and lamb skirtings into bags).

In larger clips extra lines may be made where warranted.

Suppurative Otitis in Pigs.

C. R. TOOP, Senior Veterinary Surgeon.

SUPPURATIVE Otitis, an inflammatory condition involving the deeper structures of the ear, is commonly met with in young pigs. Affected animals show characteristic symptoms the most prominent of which is the abnormal carriage of the head, which is constantly held on one side, and this may be accompanied by difficulty in maintaning balance and direction.

The disease is usually secondary to infections of the respiratory tract and is most frequently encountered on piggeries where infectious pneumonia and catarrh are prevalent. The infection reaches the ear by way of the Eustachian tube, a narrow passage which leads from the pharynx or throat to the middle ear. When the disease has become established recovery is unlikely to occur and since there is no effective method of treatment the destruction of affected animals becomes necessary.

Since the condition occurs as a complication of diseases of the respiratory tract the adoption of measures for the control of such diseases which will include attention to sanitation, housing and feeding offers the best means for its prevention.

A weaner affected by otitis. Note the abnormal carriage of the head.

SYMPTOMS.

The disease occurs principally amongst young pigs from a few weeks to about four months old, and here it should be noted that such animals are at an age where they are most highly susceptible to pneumonia and associated respiratory infections. which points to a definite association between the two conditions.

The outstanding symptoms is the abnormal carriage of the head which is constantly held on one side the affected ear being depressed and carried at a lower level than the normal one. Sometimes there is a tendency to walk

in circles the animal moving in the direction of the affected ear, i.e., if the right ear is affected the animal will circle to the right. In the more advanced cases the animal has difficulty in maintaining its sense of direction and balance. The gait becomes unsteady and the animal may have difficulty in walking in a straight line often making several attempts before it is able to reach the feeding trough. When driven, an affected pig may fall to the ground, struggling violently before it is able to regain its feet. In the later stages of the disease the animal is quite unable to maintain its equilibrium and cannot remain on its feet at all.

The condition is usually confined to one ear. Sometimes, however, both ears, become affected and although the head may be carried evenly unsteadiness of gait and difficulty in maintaining balance are marked.

Affected animals are usually in poor condition, become stunted and unthrifty, and are never profitable to maintain.

While the disease is largely confined to young pigs it may affect older animals and has occasionally been observed both in baconers and breeding sows.

CAUSE.

The disease is caused by a micro-organism known as Corynebacterium pyogenes. This organism is frequently implicated in infections of the respiratory tract including pneumonia and catarrh of the upper respiratory passages. From the throat or pharynx the infection spreads along the Eustachian tube to the middle ear subsequently extending to the internal ear. Here it sets up an inflammatory reaction accompanied by suppuration or pus formation.

The ear consists of three parts (1) The external ear; a funnel shaped organ which collects the sound waves and conveys them along a narrow canal or meatus to the tympanic membrane or ear-drum, (2) The middle ear which is separated from the external ear by the tympanic membrane and communicates with the pharynx by the Eustachian tube. It contains a chain of small bony structures known as auditory ossicles by means of which the sound vibrations from the tympanic membrane are transmitted to the internal ear, (3) The internal ear. This is a complex structure which in addition to transmitting the sound impressions received from the middle ear to sensory areas in the brain has another important function, viz the maintenance of equilibrium. It is by means of certain structures in the internal ear that an animal is enabled to retain its balance.

The symptoms which occur, i.e, unsteadiness and incoördination of gait and impairment of the sense of balance are directly related to disease of these deeper structures.

POST-MORTEM APPEARANCES.

Externally no abnormalities are usually observed.

Occasionally when rupture of the tympanic membrane has occured a brownish yellow sticky discharge may be noticed exuding into the passage of the external ear. In order to expose the focus of infection a careful dissection is necessary involving the removal of the overlying bony structures by means of a saw or other suitable instrument. When these structures have been removed an accumulation of thick cheesy pus will be observed in the cavity of the middle ear.

TREATMENT AND PREVENTION.

No effective method of treatment is available and since affected pigs remain stunted and unthrifty and recovery is unlikely to occur they are better destroyed as soon as the symptoms have become established. While there is no direct means of preventing the disease it should be recognised that it is usually secondary to infections of the respiratory tract particularly infectious pneumonia. Consequently if it is possbile to control these respiratory diseases then it should be possible to prevent otitis or at all events to greatly reduce the number of cases which are likely to occur. The measures which should be adopted in this connection must include careful attention to sanitation, housing, and feeding, and these will be practiced as a matter of course on all well managed piggeries. These measures were described in some detail in the December, 1945, issue of this *Journal* in an article which appeared under the heading "Infectious Pneumonia of Pigs."

Transport of Poultry to Market.

By E. LOVEGROVE and S. FROOME.

EVERY summer numerous deaths of poultry during transport to market are reported. The loss to the producer is considerable, especially with the present prices obtained for table poultry, and the community is deprived of an appreciable amount of valuable food which could be distributed. An endeavour to reduce this economic loss requires the co-operative effort of the poultry farmer, the Railway Department and the carriers handling the crates from the railway to the markets.

The producer has many points to watch if he wishes to place his birds "forward on rail" in the best possible condition, and ensure that his preparations will maintain suitable environment throughout the journey.

His first consideration should be not to include in the stock he intends to market any weakling which is likely to be trampled on by the more vigorous birds while in the crate. If this second quality stock must be marketed they should be segregated in one crate and allowed more space per bird. In fact, if two or three crates of poultry are to be marketed at the same time, the birds should be graded and crated according to their strength and vigour.

The type of crate used for transport should conform to certain humane and commercial standards. They must be high enough to allow the birds to stand up, be well ventilated, have receptacles for food and water, and allow ample floor space for the number of birds carried. From the commercial point of view the crates should be constructed of light timber to save freight, but well braced to allow the crates to be stacked. The floor should be close boarded, but the sides, ends and tops should be slatted to give plenty of ventilation.

After making investigations, the Railway Department suggested that a suitable crate for rail transport would be 48 inches long by 21 inches wide by 15 inches high to hold 12 to 14 fowls; the weight when filled to be approximately 112 lb. This size and weight appears to be the most convenient for efficient handling by the railway staff. Crates of this type are provided by the firms dealing with table poultry and are forwarded to the producer at his request.

In hot weather the crates should be stored in as cool and shady a spot as possible; if left in the full blaze of the sun the wood becomes warm and adds to the discomfort of the birds immediately they are crated.

The birds should be given a feed of wheat and green feed and have access to plenty of fresh water about two hours before they are crated.

Birds should not be crated before it is absolutely necessary; only the shortest possible time should elapse before they are consigned by rail or picked up by a carrier.

The problem of feed and water in the crates could be simplified if each crate contained a water tin capable of holding the wheat required for the journey. Wheat which has been soaked in water for 24 hours is placed in the tin and water is added until the surface level of the water and wheat are equal. The water absorbed by the wheat during the soaking supplies part of the requirement and the presence of wheat in the water tin prevents spilling and consequent loss of water supply.

From the time the birds are placed in the crates until they arrive at the markets the crate should always be shaded; a few minutes in the hot sun will adversely affect the birds and their chance of arriving at the market in good condition.

Crates should never be overcrowded, but in hot weather the birds should be allowed more space than is required in the winter.

The *Queensland Agricultural Journal* published in January, 1946, the results of experiments conducted on the loss of weight of poultry in transit by rail. The tests were carried out on birds of the heavy breeds and it is reasonable to expect that the proportional loss in the light breeds would be greater. The figures given were as follows:—

Distance.	Average loss per bird.	Per cent. loss per bird.
221 miles (21 hours)	5.99 ozs.	7.0
106 miles	3.0 ozs.	3.3
47 miles	3.2 ozs.	3.95

Other birds were fed and then crated at 6 p.m. and the crates were held on the farm for a number of hours.

Time held.	Average loss per bird.	Per cent. loss per bird.
12 hours	4.19 ozs.	3.84
18 hours	6.87 ozs.	6.47

It will be noted that the loss of weight is from three to seven per cent. according to the length of time the birds remain in the crates, and under adverse travelling conditions the loss would probably be much greater.

Since the advent of price fixing most birds marketed are sold by weight, so it is in the interest of the producer that the loss of weight in transit should be reduced to its minimum by practising the special care and attention suggested.

As mentioned previously the co-operation of the Railway Department is required if a reduction in the number of birds found dead on arrival at the market is to be achieved. Towards the end of 1943 investigation was made

into the cause of the mortality then occurring, and recommendations were made to the Chief Traffic Manager, who stated that the matter was being taken up specially throughout the system, in order to ensure that the best possible results were achieved. He pointed out that very comprehensive instructions were in force on the railways. These instructions are of prime importance to the poultry farmer and are, therefore, published here for his information:—

> "Before any case or crate containing livestock (animals or birds) is received for conveyance, the person accepting must see that the livestock is not overcrowded, that sufficient ventilation is provided for and that provision is made for feeding and watering on long journeys. If these conditions are not complied with the livestock must be refused.
>
> In the case of such traffic picked up at unattended sidings, and the above instructions are not complied with, guards must put the package out at the nearest station so that the contents can be transferred to a suitable box or crate at the expense of the owner.
>
> When poultry has to travel by rail 50 miles or over, water must be placed in coops, etc."

Representation is being made to the Chief Traffic Manager to emphasise the necessity of these instructions to his staff and that in the building of furthur rolling stock consideration be given to special louvred vans for poultry. It is also suggested that louvred vans be made available on stated trains for the transport of poultry only.

The last link in the chain are the carriers, and to satisfactorily conclude the transport they should be present and be able to obtain delivery of the crates of birds soon after the arrival of the trains.

It would appear that there are no unsurmountable difficulties to the reduction of the mortality which occurs in the transport of poultry to market, but, rather, that attention to detail on the part of the poultry farmer, coupled with the ready co-operation of the Railway Department and the carriers, will produce the desired result.

Muresk Egg Laying Trial No. 16

1945-46.

GENERAL REVIEW.

By K. M. COWIN, Poultry Instructor, Muresk Agricultural College.

The sixteenth test of the Muresk Egg Laying Trial terminated on 2nd March 1946.

Rainfall recorded at Muresk during the period of the trial is shown in the following table:—

1945.	Pts.	No. wet days.
April	29	3
May	172	12
June	983	24
July	213	19
August	429	27
September	203	15
October	18	4
November	67	3
December	13	2

For the period of the trial in 1946 there were no wet days so no rainfall was recorded.

The following table shows the number of days with minimum temperature of 35° and under, and maximum temperature of 95° and over at Muresk during the period of the trial.

1945.	No. of days min. 35° and under.	No. of days max. 95° and over.	Hottest day of the month.
April	–	1	98.0°
May	–	–	85.5°
June	–	–	73.0°
July	2	–	63.0°
August	–	–	68.0°
September	4	–	76.0°
October	1	–	89.0°
November	–	2	98.0°
December	–	9	100.6°
1946.			
January	–	6	100.6°
February	–	5	106.8°
March (2 days) ..	–	2	104.0°

SUMMARY OF THE RESULTS OF VARIOUS SECTIONS 1945-46.

Analyses of breed results are shown hereunder:—

Sec.	Breed.	No. of Birds.	Per cent. of Total Entries.	No. of Birds Died.	Per cent. Deaths in Sect.	No. Birds completed Test.	Production of 1st Grade Eggs.		Production of 2nd Grade Eggs.		Total Eggs Produced.	
							No.	Av. per Bird.	No.	Av. per Bird.	No.	Av. per Bird.
A.	White Leghorn	240	57·14	11	4·58	229	30,584	127·43	8,639	35·99	39,223	163·42
B.	Australorp	150	35·72	13	8·66	137	22,770	151·86	4,806	32·04	27,576	183·84
B.	Chinese Langshan	6	1·43	*nil*	*nil*	6	714	119·00	150	25·00	864	144·00
C.	Rhode Island Red	24	5·71	1	4·16	23	2,372	98·83	610	25·41	2,982	124·25
Total All Sections		420	100·0	25	5·95	395	56,440	134·38	14,205	33·82	70,645	168·20

EGG PRODUCTION.

In addition to low egg production, the percentage of second grade eggs was very disappointing. The main contributing factor was the short and irregular supply of meat-meal available for this trial.

Grading of Eggs for Weight.

All eggs were weighed in accordance with Regulation No. 2 which states:—

> "First Grade.—During the first two months of the trial a first grade egg shall weigh not less than $1\frac{7}{8}$ ozs., thereafter during the remainder of the trial a first grade egg shall weigh not less than 2 ozs."
>
> "Second Grade.—The minimum weight of a second grade egg shall be not more than $\frac{1}{4}$ oz. less than a first grade egg. Second grade eggs will be recorded but not counted."

The following table shows the various groups of egg production in the last five trials. (All eggs counted.)

Trial.	Producing 100 and under.		Producing 101–150 eggs.		Producing 151–200 eggs.		Producing 201–250 eggs.		Producing 251 and over.	
	No. Birds.	%	No. Birds.	%	No. Birds.	%	No. Birds.	%	No. Birds.	%
1941–42	31	9·06	40	11·70	108	31·58	125	36·55	38	11·11
1942–43	32	9·36	35	10·23	77	22·51	155	45·32	43	12·58
1943–44	39	9·28	67	15·95	135	32·14	136	32·38	43	10·23
1944–45	20	5·38	50	13·44	140	37·63	139	37·36	23	6·19
1945–46	37	8·81	92	21·90	190	45·24	100	23·81	1	·24

The following table shows the various groups of egg production in the separate sections. (All eggs counted.)

Sec.	Breed.	No. of Birds in Sect.	Producing 100 eggs and under.		Producing 101–150 eggs.		Producing 151–200 eggs.		Producing 201–250 eggs.		Producing 251 eggs and over.	
			No. Birds.	%	No. Birds.	%	No. Birds.	%	No. Birds.	%	No. Birds.	%
A.	White Leghorn	240	25	10·42	58	24·16	102	42·50	55	22·92	....	....
B.	Chinese Langshan	6	....	....	4	66·66	1	16·66	1	16·66	....	....
B.	Australorp	150	8	5·33	17	11·33	80	53·33	44	29·33	1	·66
C.	Rhode Island Red	24	4	16·66	13	54·16	7	29·16	....	....	....	....

WINTER TEST.

The first four months of the trial (1st April to 31st July '45) is known as the Winter Test. The following particulars show the winners and number of eggs laid.

	First grade eggs.	Second grade eggs.	Highest individual bird in team.
Section "A."			
1st R. Harrison (2)	362	41	72
2nd I. Schwarz	357	35	74
3rd H. B. Chalmer	341	69	78
Section "B."			
1st R. Harrison (2)	474	21	94
2nd Mrs. M. H. Dadley (1) ..	455	11	87
3rd M. H. Dadley	451	4	99
Section "C."			
1st M. Miller	322	38	67
2nd A. Machlin	224	52	79

GOVERNMENT STANDARD CERTIFICATE.

Standard Certificates and sealed copper bands are awarded to birds that lay 200 first grade eggs or over during the period covered by the trial.

The following table shows the number and percentage of certificate winners for all tests since the 1936-37 trial.

Trial.	No. of birds in trial.	No. of birds qualified.	Percentage that qualified.
1936-37	249	69	27.71
1937-38	240	75	31.25
1938-39	294	78	26.53
1939-40	336	68	20.23
1940-41	336	90	26.78
1941-42	342	124	36.22
1942-43	342	162	47.36
1943-44	420	140	33.33
1944-45	372	119	31.98
1945-46	420	41	9.76

Standard Certificate Winners, 1945-46.

White Leghorn.

Owner.	Bird No.	Copper band No.
Max Stocker	27	1
C. Rodgers	79	2
C. Rodgers	81	3
C. Rodgers	85	4
C. Rodgers	89	5
P. Harrison	5	6
Max Stocker	21	7
Mrs. McFadden	33	8
Mrs. J. E. Smith	70	9
Mrs. J. E. Smith	71	10
G. A. Johnson	105	11
H. P. Chalmer	123	12
H. P. Chalmer	124	13
Mrs. H. P. Chalmer	130	14
G. A. Osbourn	169	15
Mrs. W. R. Lister	190	16
Mrs. W. R. Lister	192	17
W. R. Webb	204	18
W. R. Webb	205	19
E. E. Price	220	20
Mrs. E. E. Price	234	21

Chinese Langshan.

Thos. Parker	5	66

Australorp.

H. R. Pearson	13	68
W. G. Hall	25	79
W. G. Hall	30	80
F. T. Whitfield	31	82
F. T. Whitfield	36	83
Mrs. F. T. Whitfield	45	84
W. R. Lister	55	85
A. R. Caporn	62	86
A. R. Caporn	64	87

Standard Certificate Winners, 1945-46—continued.

Australorp—continued.

Owner.	Bird No.	Copper band No.
P. Harrison	75	88
A. Machlin	80	90
E. E. Price	90	91
Mrs. E. E. Price	94	92
T. Gent	99	93
G. Barker	112	94
M. H. Dadley	120	95
Mrs. M. H. Dadley	127	96
V. J. Dadley	134	97
Miss J. M. Dadley	139	98

FINAL LEADING SCORES

Competitor.	First grade eggs.	Second grade eggs.	Score of highest bird in team.
Section "A"—White Leghorns.			
1st Mrs. McFadden	1016	106	226
2nd C. Rodgers (2)	1010	45	204
3rd R. Harrison (2)	998	212	197
Section "B"—Australorps.			
1st Mrs. M. H. Dadley (2)	1119	66	225
2nd Mrs. F. T. Whitfield	1113	45	223
3rd F. T. Whitfield (1)	1063	129	223
Section "B"—Chinese Langshan.			
Thos. Parker	714	159	203
Section "C"—Rhode Island Reds.			
1st M. Miller	699	182	176
2nd A. Machlin	605	118	169
3rd G. E. Price	588	104	124

At a social arranged by the Committee of Management in the Shell Oil Co's. Theatrette and Social Rooms, St. George's Terrace, Perth, on 9th May 1946, the Hon. J. T. Tonkin, Minister for Agriculture presented the trophies to the successful competitors in the 1945-46 Muresk Egg Laying Trial.

Trophy List showing donors and successful competitors.

Prize List.

Champion Certificate—W.A. Produce Trophy. Score.

Owner: Mrs. M. H. Dadley—

First grade 1,119

Second grade 66

Team of Six Birds—Section "A" Light Breeds—White Leghorns.

First prize (Westralian Farmers and Eggoleen Cups, J. Freecorn and Westralian Farmers Trophy. Owner: Mrs. McFadden—

First grade 1,016

Second grade 106

Second prize (L & M. Cullen Trophy). Owner: C. Rodgers— Score.

First grade	1,010
Second grade	45

Third prize (Boans Trophy). Owner: R. Harrison—

First grade	998
Second grade	212

Team of Six Birds—Section "B" Heavy Breeds—Australorps.

First prize (Associated Agents Cup, J. Inkpen and L. J. Kendall Trophy). Owner: Mrs. M. H. Dadley.

First grade	1,119
Second grade	66

Second prize (Haynes & Clements Trophy). Owner: Mrs. F. T. Whitfield—

First grade	1,113
Second grade	45

Third prize (F. W. Wright Trophy). Owner: Mr. F. T. Whitfield—

First grade	1,063
Second grade	129

Team of Six Birds—Section "C" Medium Heavy Breeds—Rhode Island Reds.

First prize (Dunklings Cup, R. B. Young and J. Lori Trophy). Owner: Mr. M. Miller—

First grade	699
Second grade	182

Second prize (Associated Agents and J. Goss Trophy). Owner: Mr. A. Machlin—

First grade	605
Second grade	118

Winter Test (from 1st April to 31st July).

Section "A" Light Breeds.

First prize (C. A. Kirkby and J. Scanlon Trophy). Owner: R. Harrison—

First grade	362
Second grade	41

Section "B" Heavy Breeds.

First prize (M. H. Dadley and A. R. Caporn Trophy). Owner: R. Harrison—

First grade	474
Second grade	21

Section "C" Medium Heavy Breeds.

First prize (Mrs. S. Giles Trophy). Owner: M. Miller—

First grade	322
Second grade	38

Summer Test (from 1st December to 2nd March). Score.

Section "A" Light Breeds.

First prize (Western Ice Co. Cup and Deputy Controller Egg Supplies Trophy). Owner: Mrs. McFadden—

First grade	285
Second grade	35

Section "B" Heavy Breeds.

First prize (Western Ice Co. Cup and Thomas & Co. Trophy). Owner: F. T. Whitfield—

First grade	260
Second grade	38

Section "C" Medium Heavy Breeds.

First prize (Western Ice Co. Cup and R. Piercey Trophy). Owner: G. E. Price—

First grade	131
Second grade	31

Individual Birds.

Section "A" Light Breeds.

First prize (Macfarlane Cup and Multiplo Trophy). Owner: Mr. G. A. Johnson, Bird No. 105—

First grade	234
Second grade	5

Second prize (York Flour Mills Trophy). Owner: C. Rodgers, Bird No. 81—

First grade	231
Second grade	2

Section "B" Heavy Breeds.

First prize (Baird Cup and M. Bell Trophy). Owner: Mrs. E. E. Price, Bird No. 94—

First grade	235
Second grade	6

Second prize (Malloch Bros. and J. Banfield Trophy). Owner: M. H. Dadley, Bird No. 120—

First grade	233
Second grade	3

Section "C" Medium Heavy Breeds.

First prize (Enston Cup and W. Hoops and W. Southern Trophy). Owner: M. Miller, Bird No. 26—

First grade	176
Second grade	15

First Bird to Lay 200 First Grade Eggs.

Section "A" (Flint and Eldridge Trophy). Owner: G. A. Johnson, Bird No. 105, 4th January, 1946.

Section "B" (M. A. Gordon Trophy). Owner: Mrs. E. E. Price, Bird No. 94, 3rd January, 1946.

Section "C"—Nil.

Special Prizes.

Teams of Six Birds judged for type by Messrs. Love and Lethbridge.

Section "A" Light Breeds.

First prize (W. Lister and T. Newby Trophy). Owner C. Rodgers, Pens 79-84.

Second prize (A. Richards Trophy). Owner: R. G. Gent, Pens 43-48.

Section "B" Heavy Breeds.

First prize (Carbarn, Mulberry and McLean Trophy). Owner: Mrs. F. T. Whitfield, Pens 43-48.

Second prize (Foy & Gibson and W. H. Milne Trophy). Owner: Mrs. M. H. Dadley, Pens 121-128.

Section "C" Medium Heavy Breeds.

First prize (Barrow, Linton and S. Froome Trophy). Owner: M. Miller, Pens 25-30.

Team Laying Lowest Percentage Second Grade Eggs; minimum lay 1,000 *eggs.*

D. H. Doust and Harrold and Murray Trophies. Owner: Mrs. F. T. Whitfield (Australorp)—

	Score.
First grade	1,113
Second grade	45

Bird Laying Longest Sequence First Grade Eggs.

J. & W. Bateman Trophy. Owner: G. Barker, Australorp No. 108; sequence 58.

Bacterial Canker of Tomatoes.

W. P. Cass Smith, Plant Pathologist.
O. M. Goss, Assistant Plant Pathologist.

BACTERIAL canker of tomatoes was first recorded in Western Australia in December, 1945, in the Wanneroo and Balcatta areas. Subsequently it was also identified from the Denmark and Coogee districts.

The disease was apparently introduced with seed stocks imported from the Eastern States of Australia where it has occurred for some years, and the variety Tatura is particularly suspect, as three badly infected and widely separated crops of this variety originated from seed which was traced to the same source.

Bacterial canker is recognised as a very serious disease in many countries of the world, and in this State it has also caused heavy losses in some affected crops, amounting in two cases to almost total destruction. It appears to be more serious in staked and pruned, than in unstaked crops, and also in crops grown under sprinklers, rather than on moist land or furrow irrigated. Not only does the disease affect the market quality of the fruit, but by causing premature death of plants it seriously reduces the yield also. Steps have already been taken with the object of preventing the spread of the disease in affected areas, and reducing other sources of infection, but all tomato growers are advised to familiarise themselves with the symptoms of bacterial canker and the methods whereby it may be avoided.

Fortunately in this State most commercial growers save their own seed, and this practice should help to prevent a widespread establishment and assist in the control of this serious seed-borne disease.

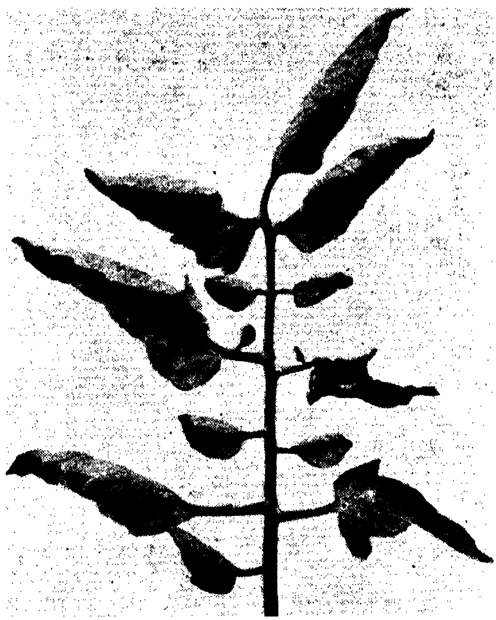


Fig. 1.—Single leaf showing early stages of disease. Note uprolling of leaflets and slight marginal withering. Note also that a single leaflet has shrivelled before the remainder.

Symptoms and Effects.

Typically the disease spreads from the base of the plant upwards causing the lower leaves to die progressively up the stem. Death of the leaves is preceded by a gradual marginal withering and upwards rolling of the leaflets (Fig. 1) frequently confined at first to single leaflets, or the leaflets on one side of the leaves only which shrivel up before the remainder (Figs. 1 and 2). Eventually the whole leaf shrivels and dies, and hangs down, but it does not fall readily from the plant, for the leaf stalk remains erect and stiff and only gradually withers (Fig. 3). If such infected leaves are broken from the stem a discolouration of the water conducting tissue is visible, yellow at an early stage and brown at a more advanced stage of the disease.

When cut in section the stem shows definite browning of the water conducting tissues extending into the pith which also becomes yellowed and finally dark brown. There is a tendency to mealiness and to the formation of pockets in the pith which finally becomes hollowed out. Browning and breakdown of the pith is more definite at the nodes, and there is little evidence of the disease in the below-ground parts of the plant (Fig. 4, a, b, and c).

During wet weather or when overhead sprinklers are used, whitish, round to oval, spots often appear on stems (Fig 5a), leaf stalks, and sometimes on the leaves also. When the fruit develops it may also show this external spotting, white at first, then with a brownish and usually cracked centre (so-called bird's eye spotting) (Fig 6). This symptom, when it occurs, is absolutely diagnostic of the disease.

Fig. 2.—Single leaf (still attached to plant) at later stage of the disease. Note shrivelled leaflets on one side of leaf only, and marginal withering and uprolling of remainder.

In the later stages of disease development, the stems show elongated whitish patches which may split longitudinally, giving cankers, although under our conditions canker formation appears to be rare (Fig. 7). Sometimes the small white spots on the stem (Fig. 5a) may split and develop into secondary cankers.

Fig. 3.—Young plant inoculated by means of needle prick with *A. michiganense* (three weeks after inoculation). Note withered leaves which hang down from the erect leaf stalks.

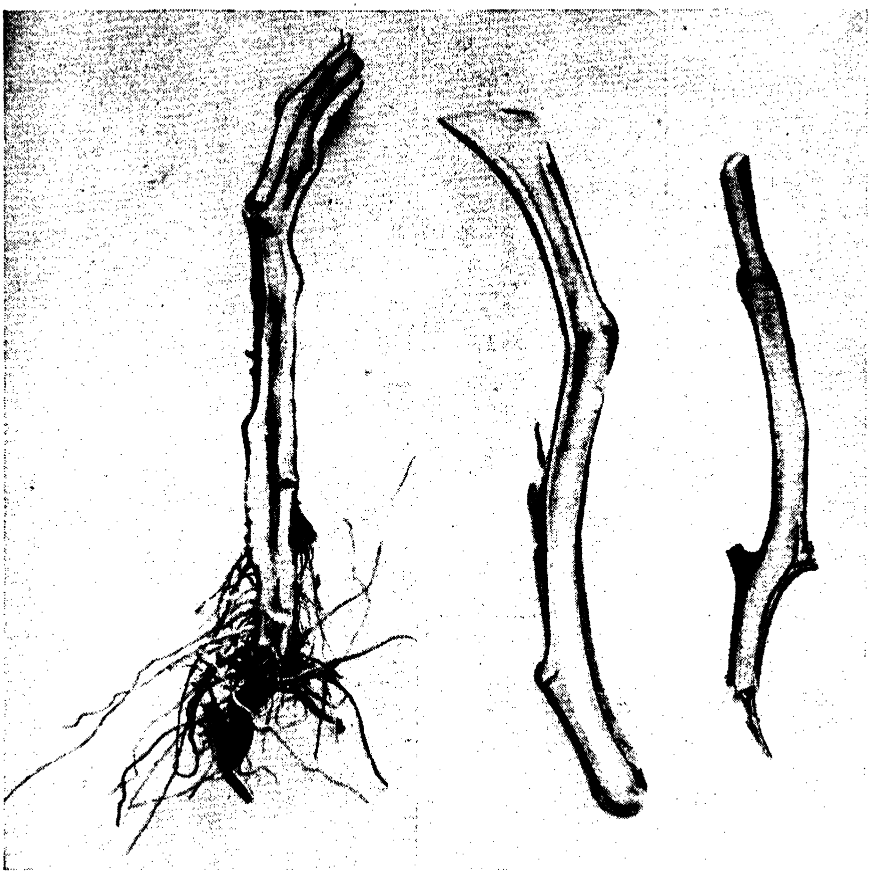
The fruit often drops prematurely and may show a browning beneath the calyx lobes. In badly affected fruits the browning extends internally resulting in brownish discoloured areas and brown water conducting strands (Fig. 5b).

Superficially bacterial canker resembles fusarium wilt but the one sided withering of the leaves, the absence of leaf yellowing, the formation of pockets in the pith, and the fruit spots and stem cankers when present, serve to distinguish it from the latter trouble.

Development of the Disease.

The disease is caused by a bacterial parasite *Aplanobacter michiganense* and these minute organisms are generally introduced into new areas by means of infected seed or seedlings.

The bacteria invade the fruit of diseased plants through the water conducting strands, with the result that the seeds become infected. Fruit invaded at an early stage may show internal discolouration (Fig. 5b) but it should be noted that fruit invaded at a later stage of development may ripen normally, and show little or no internal evidence of the disease to the naked eye.



(c) (b) (a)

Fig. 4.—Longitudinal sections of stems.
(a) Early stage, showing browned water-conducting strands in stem and leaf stalk.
(b) Later stage showing in addition slight discolouration.
(c) Final stage with pith very dark and tending to break down and form cavities. N.B.—Widening of discolouration at nodes.

However, the seeds saved from such fruit may give rise to the disease when planted.

When infected plants are present in either seed-bed or field, the disease may be spread in any of the following ways:—

(a) Handling of seedlings during transplanting, if a diseased seedling is handled prior to healthy ones.

(b) During pruning. This is a most important means of spread, for Ark (1944)[1] in America was able to transmit the disease to over 30 consecutive plants after cutting one diseased plant with the pruning knife.

(c) In the splash from sprinklers, rain, etc., especially if wounds are present on the plant. (This also gives rise to the surface fruit spots which make fruit unsightly and lower its market value.)

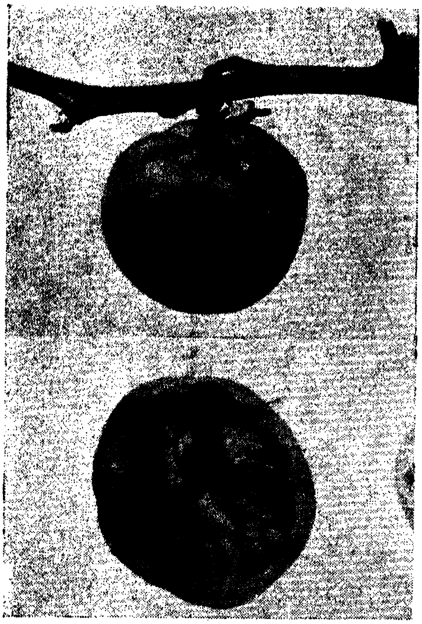


Fig. 5.

(a) Portion of stem and attached fruit showing external whitish spots caused by splashing with water containing the canker organism.

(b) Longitudinal section of tomato fruit showing browning below calyx lobes, brown discoloured areas in pith and browned water-conducting strands due to presence of the disease.

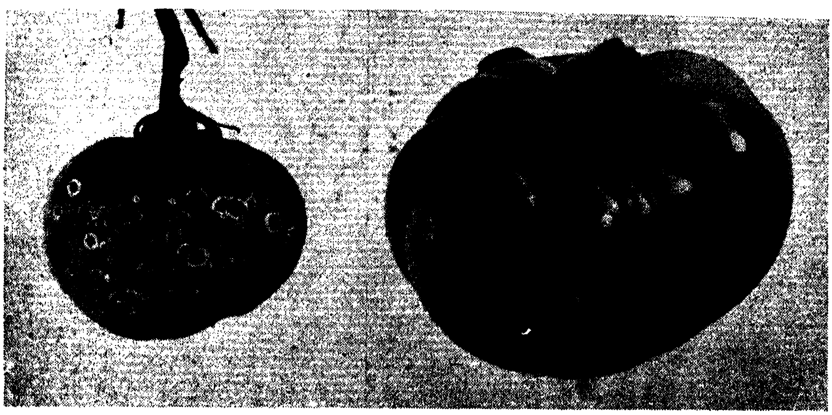


Fig. 6.—Fruit showing "bird's eye" spotting due to external infections with the canker organism. On left: badly infected fruit. Note white haloes and dark centres of spots. On right: early stage of spot.

Once the disease has occurred in an area, either seed-bed or field soil, it may remain in the soil and infect the next crop of tomatoes.

Control.

(1) Seed should be saved only from crops entirely free of canker. This is most important as the primary spread of the disease is due to infected seed.

(2) Seed should be extracted by fermenting the pulped fruit without water for four days in a cool shady place. The fermenting material should be stirred night and morning to submerge pulp floating on the surface.

(3) Purchased seed or seed unavoidably saved from crops in which even traces of canker had been noticed should be disinfected either by steeping for 25 minutes in water maintained at 122° F. or in 0.6 per cent. glacial acetic acid solution (one fluid ounce of acid in a gallon of water) for 24 hours. The hot water treatment is preferred as it is said to be effective not only against bacterial canker, but also against all other seed-borne diseases of tomato[2], including early blight or target spot, fusarium and bacterial wilts. After treatment, seed should be dried thoroughly and dusted before planting, with spergon (tetroc) or one of the organic mercury dusts, e.g., ceresan, agrosan, etc. This treatment guards against damping off and often results in improved germination.

Fig. 7.

Stem of diseased plant showing elongated, light, sunken patches, which may split to form cankers, as in specimen. Canker formation appears to be rare under our conditions.

(4) Diseased crop remains should be burnt, not ploughed in, as the organism can live for at least two years in the soil.

(5) Once the disease has occurred do not crop land with tomatoes for at least three years.

(6) Seed-bed sites should be changed at each planting, and if permanent wooden frames or seed boxes are used, these should be disinfected by drenching with two per cent. formalin (one gallon commercial formalin in 49 gallons of water) or two per cent. bluestone solution (one pound in five gallons of water).

(7) During pruning, if a diseased plant is handled or cut, the hands and knife should be thoroughly washed in soapy water before other healthy plants are dealt with.

(8) If a diseased plant is discovered during pruning, etc., rogue it out and burn it as it serves as a source of infection to neighbouring plants during splash from sprinklers, rain, etc.

(Full details of the simple, home-made apparatus required for carrying out a hot water seed treatment are given in advisory leaflet 747 obtainable free of charge from the Department of Agriculture.)

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(1) ARK, P.A.—Studies on Bacterial Canker of Tomato. *Phytopathology*, Vol. 34, No 4, April, 1944.

(2) U.S.D.A. *Farmers' Bulletin*, No. 1934 (1943)—Tomato Diseases.

EXPERIMENTAL.

The Organism.

The casual organism is most readily isolated from the petioles of diseased leaves, especially those showing the early stages of the disease. The method found most satisfactory is aseptic plating of expressed sap. Of the standard laboratory media tried the organism grows most readily on Potato-Dextrose Agar or Potato-Dextrose-Peptone Agar.

The bacteria are very short rods with rounded ends occurring singly or in pairs. They are gram positive and non-motile, and no evidence of spores or capsules was seen.

On *Meat Extract Agar* the colonies are small, circular, smooth, slow-growing (four to five days to become visible at a temperature of about 27° C.) pale yellow becoming darker with age. On *Potato-Dextrose Agar* growth is more rapid and cream-yellow in colour. In *Nutrient Broth* a slight turbidity is developed but no pellicle or rim is formed. On *Steamed Potato* a small amount of yellow slime develops. *Gelatine Stab*—there is a very slow growth which sinks slightly into medium but shows no sign of liquefaction even after six weeks. *Litmus Milk*—a soft curd is formed in about eight days. Later a yellow rim develops followed by a complete pellicle. No peptonisation occurs. The litmus is reduced. There is no growth in *Cohn's* and *Fermi's* solutions. Starch is not hydrolysed, nitrates are not reduced and there is no production of indol. No acid and no gas are produced from sucrose dextrose, mannite, maltose, lactose, salicin or glycerol for several weeks but after about one month there is a slight acid production from sucrose, maltose and salicin.

The above description agrees very closely with that given for *Aplanabacter michiganense*, except that it failed to liquefy gelatine.

Inoculation tests were done into healthy tomato plants using needle pricks into the basal stem region—control plants being pricked similarly with a sterile needle. In 12 days the inoculated plants showed definite symptoms of disease—the lower leaves wilting and tending to wither (Fig. 3). In 32 days the plants were dead. Isolations from petioles gave an organism similar in all respects to the one used for inoculation. The control plants remained healthy.

This disease is known to be seed borne but great difficulty has been experienced in actually isolating it from the seed by cultural methods. From seed collected by Mr. Russell of Balcatta from apparently diseased plants numerous plates were made using the following techniques.

(1) Direct platings of seed on Meat Extract Agar.

(2) Seed washed in sterile water and plated.

(3) Seed surface sterilised with alcohol (one minute) and plated.

(4) Seed surface sterilised with $HgCl_2$ 1/1000 for one minute, and washed in sterile water.

None of these techniques, however, yielded the organism—in the case of 1 and 2 probably because of its slow growth compared with other saprophytic organisms present on the seed, and in 3 and 4 because the seed, in this case, was probably only surface contaminated and the organisms were therefore killed out.

Later, seed was extracted by the authors from fruits which were first proved to contain the disease both in the pulp and in the vascular supply and this was saved for further experiment. From this seed the organisms were obtained by direct plating both on Meat Extract Agar, Potato-Dextrose Agar and Potato-Dextrose Agar plus peptone. It is, however, realised that such highly infected samples are rare, so experiments are in progress to determine the age at which it is first possible to demonstrate the disease in seedlings.

Experiments on Seed Treatments.

In an effort to determine the most effective seed treatment control measures for this disease, preliminary experiments have been carried out with hot water, acetic acid dip and long fermentation in the extraction of seed. (See control measures (2) and (3) pages 152 and 153.)

1. *Hot Water Treatment.*—The following experiments were performed to try and ascertain (a) the effect of water temperature and duration of exposure, on the organism and seed germination, (b) the effectiveness or otherwise of the standard hot water treatment (25 minutes at 50° C.) [2]. Suspensions of the bacteria in sterile water were subjected to varying temperatures for varying periods, as set out in the table below, and at the same time samples of seed were immersed in water at the same temperatures and for similar periods. In each case the test tube of water to which the organism was added was first raised to the required temperature and held constant in a water bath for the required time. A loopful of of the suspension was subsequently smeared over the surface of agar in each case.

Water Temperature.	Period mins.	No. of Colonies on Plate.	Seed Germination. %
49°C.	15	6 colonies	95
	20	2 colonies	96
	25	Nil	97
	30	Nil	97
	35	Nil	98
50°C.	15	Nil	97
	20	Nil	97
	25	Nil	96
	30	Nil	96
51°C.	15	Nil	99
	20	Nil	98
	25	Nil	99
	30	Nil	99
55°C.	25	Nil	98
Control Untreated Seed	...	...	98

It therefore appears that exposure to water at a temperature of 50° C. or above for these periods is effective in killing out the canker organism, at least when in water suspension, and that these treatments did not impair the germination of the seed.

In a number of tests conducted later it was shown that neither is the germination of good seed samples, nor the subsequent growth to maturity of several popular varieties impaired by the standard hot water treatment.

Pot experiments also were carried out to determine the effectiveness of the standard hot water seed treatment, using a sample of diseased seed—

(1) Were untreated.

(2) Were treated with hot water.

(3) Were treated with hot water and then surface contaminated with a pure culture of *A. michiganense*.

After 14 days, counts were made of the number of germinated seeds, giving the following results 15:16:12 respectively—four days later it was 16:16:9. Presumably the external contamination of the seed had killed off three of the young seedlings in pot 3. After three months the plants in pot 3 were showing definite signs of canker and were dying off (the organism was re-isolated). By three and a half months there were only five plants left and these were all showing symptoms of disease. After three and a half months, five of the plants in pot 1 were showing canker symptoms and the organism was isolated from these. No pruning was done at any stage and no transplanting. No external cankers developed and no surface spotting—the most obvious symptom being the wilting, rolling and withering of the leaves. The plants in pot 2 still showed no evidence of canker but were becoming unthrifty due to crowding and bad weather conditions.

2. *Acetic Acid* 0.6 *per cent. for* 24 *hours.*—Germination tests on seed samples.

	Untreated.	Acetic Acid.	Hot Water.
	%	%	%
(1)	60	9	41
(2)	98	92	97

N.B.—(1) was a poor sample of seed giving a low germination even when untreated—but with good seed samples neither acetic acid nor hot water injures the germination.

3. *Long Fermentation.*—Germination 92 per cent.

Field experiments have shown that there is no harmful effect on subsequent growth following any of these treatments, but preference is given to the hot water treatment as it is more effective against internally born canker disease and also against other seed borne diseases.

Other Hosts.

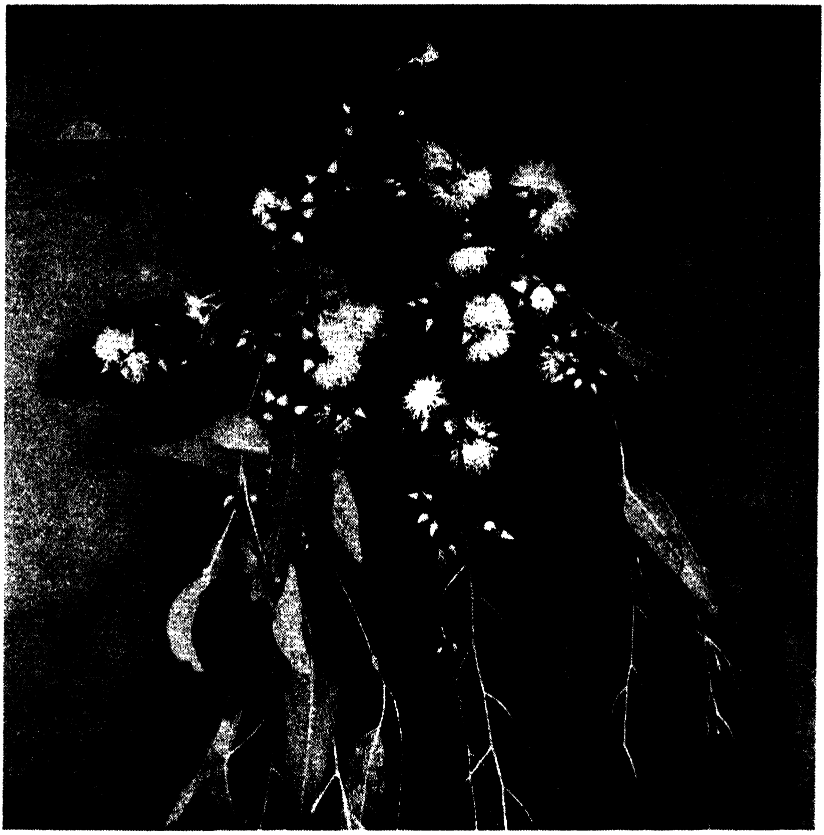
To determine whether other related plants were susceptible to infection with canker, inoculations were done to tomato, Solanum nigrum (four plants inoculated in all) and potato creeper. The tomato was the only plant which developed the disease.

The Main Honey Producing Flora of Western Australia.

L. BLAIR, Government Apiculturist.

THIS leaflet is written with the object of assisting the younger apiarists in the State and in response to the growing number of inquiries in regard to the different flowering periods of the main honey bearing eucalypts. These trees are the main source of honey gathered in W.A. and their flowering periods and bud development vary to a marked degree. A general knowledge of their habits should be a help to the young apiarist in mapping out his inspection of areas prior to moving or migrating bees to the different districts to take advantage of the honey flows as they occur. Seasonal conditions to a great extent govern the secretion of nectar, and often a genus of plants or trees may have a good showing of bloom with very little or no nectar. Then again it may have a fair secretion of nectar and very little or no pollen. The pollen may be very dry and will be blown off by a light breeze and the bees may not be able to gather sufficient pollen to stimulate brood rearing.

The majority of districts that have any cleared portion of land throughout W.A. contain a liberal quantity of Cape Weed (*Cryptostemma calendulacem*). This plant, an introduced one from South Africa, being one of the first main flowers in the spring, contains, generally, a liberal quantity of both nectar and pollen; blooms July to October, varying somewhat in different districts; and is the main factor in building up the strength of the hives after the winter months. Prior to this blooming the Flooded Gum is practically the first eucalypt to bloom. Very often this tree blooms in very wet weather and the bees do not obtain the full benefit from this species.



Flooded Gum.

YORK GUM (*Eucalyptus rudis* Endl).—This species blooms in the early summer and is a regular annual flowering variety being naturally better some seasons than others. The bud development is about nine to ten months. The honey is only a second grade. This eucalypt grows on good agricultural land and a large area has been cleared for cereal cropping.

The next eucalypt to follow is the Coastal Jarrah (*E. marginata*). The blooming of this eucalypt varies in different districts as much as six weeks. However, the general period for blooming in the coastal areas starts about the end

of October to December, and later in the hills and on heavier soils. This honey is a dense honey and has a nice "nutty" flavour in the coastal districts and tends to become much darker in the heavier soils, contains a larger proportion of *levulose* and seldom candies. Bud development is approximately nine to ten months.

Coastal Jarrah in flower with seed pods showing on bottom of spray. Note the perforation of the leaves caused by the parasite moth (Tinea spp.).

The next to flower is the Wandoo (*E. redunca* var. *elata* Bth) or Summer White Gum. This eucalypt, in my estimation, is one of the best honey producing trees in Australia, being very reliable and a prolific source of nectar with an ample supply of pollen. The flowering period extends from three to five months. The honey is of first class quality, varying in colour from amber to light amber, good density, granulation of medium grain and light creamy colour. This species starts flowering in November and December and finishes off about March, varying somewhat in different districts and localities. The White Gum flowers sometimes two and three years in rotation, then most likely will have a two years' spell during which period the new growth with buds will be developing, the development period of these buds covers a period of two years. It is very necessary for apiarists to familiarize themselves with the appearance of these buds just

prior to their coming into bloom. At this stage the bud caps assume a deep reddish brown colour. This colour is pretty general with the majority of the eucalypt caps prior to flowering. Particular attention should be paid to this characteristic as a mistake in migrating apiaries to a district before the buds are ready to flower would involve the apiarist in a great deal of unnecessary expense and would entail a further shift to pastures new.

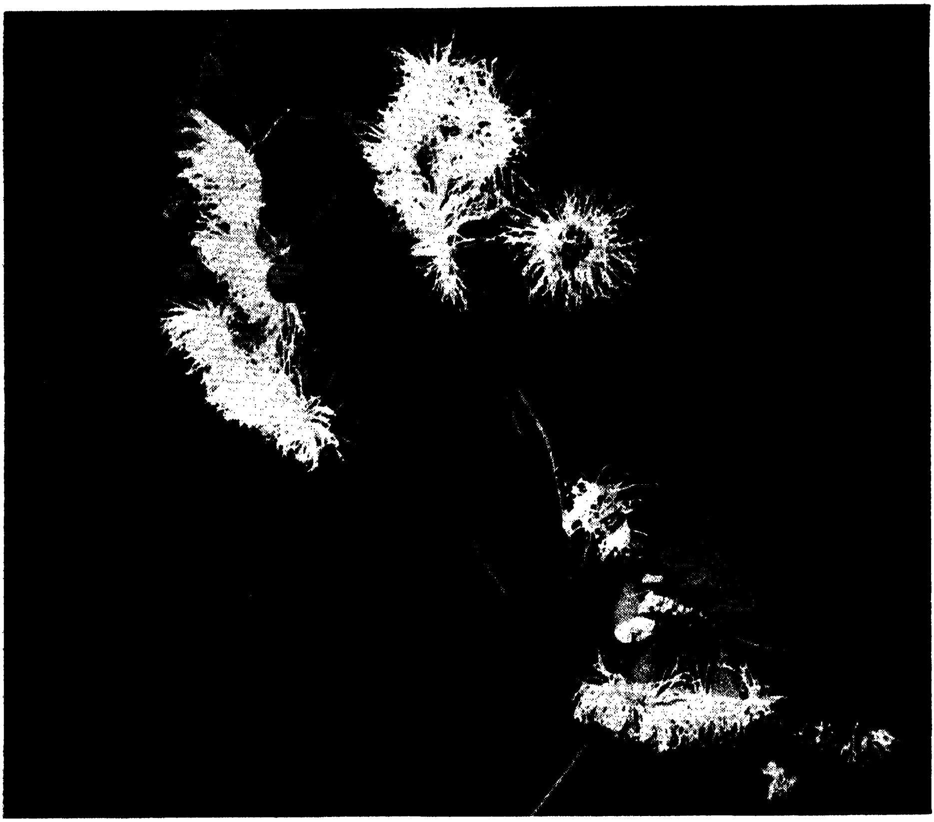
Winter White Gum.—A heavy honey producer.

WINTER WHITE GUM.—A eucalypt indistinguishable from (*E. reduncа* var. *elata* Bth) but has a different flowering period. The early trees begin blooming about March and often continue right through the winter months. This variety grows mainly on the foothills of the Darling Range extending north beyond Moora. It is a good heavy yielder of a first class honey with a fairly even grained candy. The bud development period is two years, the same as the Summer White Gum.

The POWDER BARK WANDOO (*E. accedens*).—This tree grows in the same country as the White Gum and, to the casual observer, could be mistaken for White Gum. On closer investigation there are a great number of different features by which it can be recognised. First the appearance of the bark, which has a salmon colour and if rubbed it leaves a quantity of light coloured powder on the hand. The leaves are wider and the buds are of a different shape. This species comes into flower just before the Summer White Gum bloom finishes.

This tree only blooms about once in a four-yearly cycle. The honey is of first-class quality, good flavour, and density, and a very fine grained candy when crystalised. The flow of nectar varies considerably in different districts and cuts out as soon as the wet season approaches.

MARRI or RED GUM (*E. calophylla* R. Br.).—This eucalypt is a very striking tree when in bloom and develops its buds and flowers within three months. With weather and soil conditions being favourable it is a good yielder



Marri or Red Gum.—A heavy honey producer when seasonal conditions are favourable. New growth buds and flowers develop within three months.

of nectar and pollen, in a favourable season the nectar will fill the flower cups and drip nectar from them. The conditions for a good flow from this species are a damp subsoil with humid weather or heavy dewy nights, and absence of seed vessels in great numbers being ripened on the tree from a previous setting. The period of flowering extends from February to March and April generally, and varies somewhat as to length of flow according to seasonal conditions. This honey also is considered of first class quality but varies somewhat according to the district, the heavier soils as a rule producing the better honey. Red Gum or Marri honey in the sandy coastal districts is not as a rule of such high grade quality as in heavier soils.

TUART (*E. gomphocephala* D.C.).—**This eucalypt is situated mainly on the south-west limestone country around the coast extending from Busselton in the south-west to the Moore River in the north. The flowering of this species is very irregular owing to the depredation of the Borer Grub; a weevil like pest that lays eggs**

Tuart.—Note the caps being pushed off prior to the opening of the flowers in the left spray.

in the buds and then drops the cluster of buds on the forest floor. This pest is responsible for the loss of tons of honey every year but is, however, attacked by a wasp parasite. When the parasite becomes strong enough to combat the pest the tree produces a good quantity of flowers the honey produced being of a pleasing flavour and when candied is very solid and fine grained. This tree is a most uncertain yielder and it may be four to seven years between flows; the buds taking two years to develop.

KARRI (*Eu. diversicolor*).—This giant of the forests is a beautiful tree with a height of up to 250 feet and a trunk of up to 100 feet before the first branches. This giant begins flowering sometimes in June and, in general, a flow continues until the next April. Six to eight months when conditions are favourable. The honey is a general favourite and in the fancy grade; being very light in colour, good density, and very white when crystalised. The buds take 18 months to two years to develop and they have a flowering cycle of approximately once in four years. The pollen sometimes is on the light side and bees working on this flow are often extremely hostile to manipulate. It is not advisable to leave hives in the karri country during the winter, particularly if they are in the shade, as the district has a heavy rainfall and a number of the hives are apt to die out during this period or early the following spring.

SALMON GUM (*E. salmonophloia* F. v M.):—This eucalypt is a very uncertain honey producer varying greatly in its flowering periods at different seasons of the year. Bud development uncertain: Honey second grade.

SWAMP YATE (*Eucalyptus occidentalis* Endl).—The honey from this variety is very choice being very mellow to the palate, light in colour and when candied a very fine grained easy spreading variety. Rather uncertain yielder as the buds are often attacked by parasites and the gathering period interrupted by wet weather as its flowering time is in April and May. Usually flowers every year.

There are a great number of other species of trees, shrubs and ground flora that have not been listed in this article. These comprise over 50 varieties of Banksia alone that bloom at different times of the year and in different districts, also the Mallees and Marlocks which also number many different varieties and blooming periods, numerous ground flora and bushes which will become familiar to apiarists, as they work and become acquainted with their own districts and the seasons of their flowering periods. As there is such a number of flowers that yield nectar it would take a large volume to list them all. The list compiled here, however, should give the new apiarist an idea in which district and timber country to inspect for future flows. The enterprising apiarist should have a rough programme of possible flowering periods mapped out about 12 months ahead and have his hives strong and ready to place on to different locations and not wait for the bees to build up on the flow as in a short blooming period half the flow will be over before the hive is strong enough to take full advantage of it.

Always remember, leave enough honey in the hives just prior to a flow cutting out. This precaution is necessary, sometimes to see the bees safely through a dearth period, or between flows, or to carry them safely through the winter. It is bad policy to extract all the honey and later on find it necessary to feed the bees to see them through a lean period.

Erratum.

In the *Journal of Agriculture*, Vol. XXII., No. 4, December, 1945, article on "Subterranean Clover Seed Production," page 364, paragraph 3, Conclusions, for "Dinoc can play an important part in the control of broad leaved weeds in onion crops. Spraying should be carried out when the weed seedlings are very small at which stage a 1:120 solution plus 2 lb. of sulphate of ammonia per gallon at 100 gallons per acre is very effective and causes negligible damage to transplanted onions," read "Dinoc can play an important part in the control of broad leaved weeds in onion crops. Spraying should be carried out when the weed seedlings are very small at which stage a 1:120 solution plus 2 lb. of sulphate of ammonia per 100 gallons at 100 gallons per acre is very effective and causes negligible damage to transplanted onions."

By Authority: WILLIAM H. WYATT, Government Printer, Perth.

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Preparing the Farm Seed Supplies.

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IN the quest for higher yields the farmer is concerned with a number of sources of possible loss. When seed bed preparation and planting dates are satisfactory, the highest yields will be obtained from the best seed sample of the variety most suited to the district. The farmer is therefore concerned firstly with the choice of suitable varieties for his district and secondly with ensuring grain supplies of them for seed purposes.

For the 1945 seeding, twelve varieties accounted for over 90 per cent. of the acreage sown to wheat for all purposes in W.A., and 70 per cent. of the total was sown to the three leading varieties. (Samuel 1945). This indicates the importance which farmers attach to the selection of the best varieties of cereals for their district.

The Department of Agriculture is concerned firstly with producing new and improved varieties by crossbreeding and selection, and secondly with ensuring that supplies of pure seed of them are available to farmers. To maintain the variety so that it breeds "true" for the desirable superior characters, the Department maintains pure lines of the recommended cereals. The maintenance of pure line rows involves a pedigree system which immediately reveals any deviation from type.

The surplus seed from the pedigree rows is increased each year until sufficient is available for distribution to the industry. (Fig. 1). The identity and therefore the pedigree of all seed is maintained during the years of increase. Many farmers ensure their supplies by buying each year sufficient pedigree seed from the Department of Agriculture for a small plot which is gradually built up until sufficient is available for planting the whole farm. This system enables the farmer, with appropriate care, to maintain his varieties free of admixture and therefore capable of giving the highest yields within the capacity of that variety.

Numerous experiments have shown that the larger grains will yield more than smaller ones of the same variety. This indicates the desirability of grading seed if maximum yields are to be obtained and all seed distributed from the Research Stations is so treated.

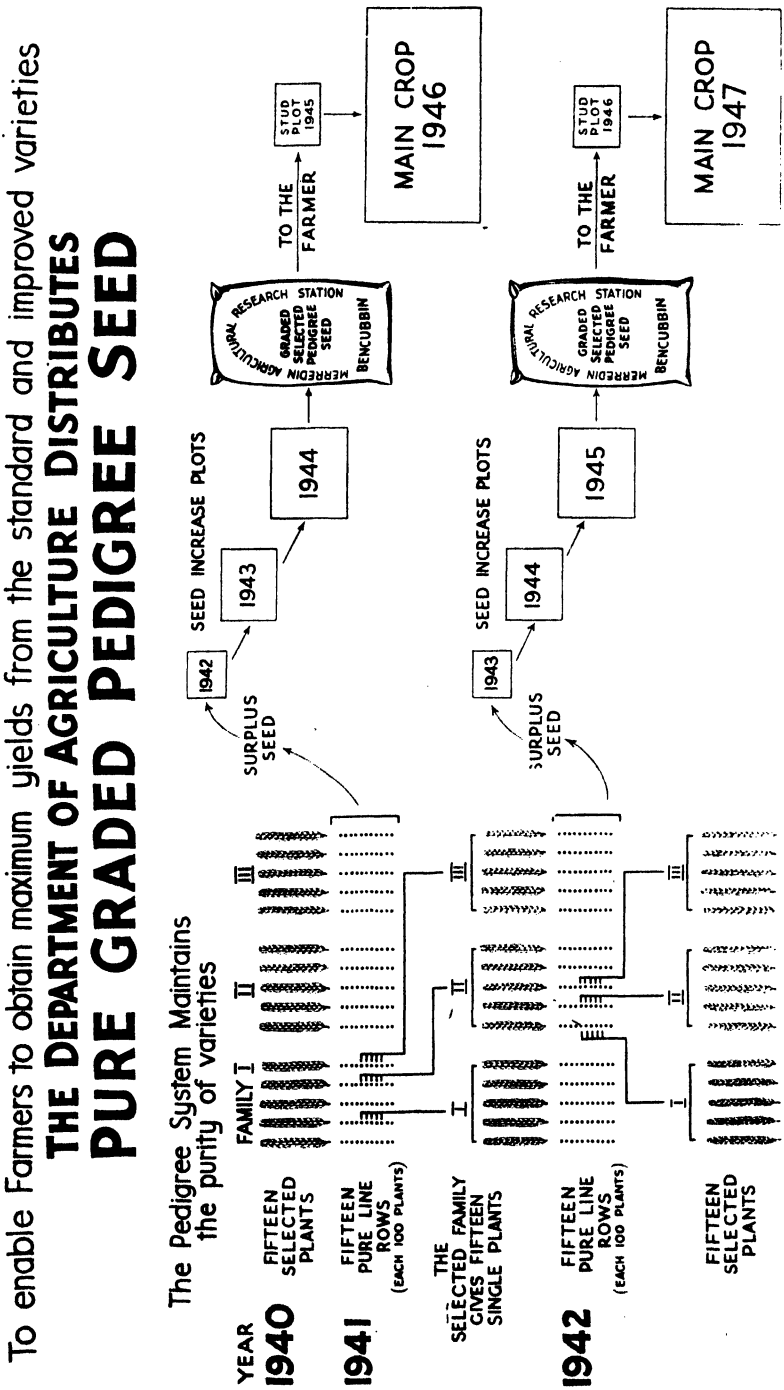
To enable Farmers to obtain maximum yields from the standard and improved varieties
THE DEPARTMENT OF AGRICULTURE DISTRIBUTES
PURE GRADED PEDIGREE SEED
The Pedigree System Maintains the purity of varieties
YEAR
1940
FIFTEEN SELECTED PLANTS
FAMILY I
II
III
1941
FIFTEEN PURE LINE ROWS (EACH 100 PLANTS)
THE SELECTED FAMILY GIVES FIFTEEN SINGLE PLANTS
I
II
III
1942
FIFTEEN PURE LINE ROWS (EACH 100 PLANTS)
FIFTEEN SELECTED PLANTS
I
II
III
SURPLUS SEED
1942
SEED INCREASE PLOTS
1943
1944
MERREDIN AGRICULTURAL RESEARCH STATION
GRADED SELECTED PEDIGREE SEED
BENCUBBIN
TO THE FARMER
STUD PLOT 1945
MAIN CROP 1946
SURPLUS SEED
1943
SEED INCREASE PLOTS
1944
1945
MERREDIN AGRICULTURAL RESEARCH STATION
GRADED SELECTED PEDIGREE SEED
BENCUBBIN
TO THE FARMER
STUD PLOT 1946
MAIN CROP 1947

Fig. 1.

In a previous paper by the Authors (1944) the utilisation of the main cereal varieties was discussed. In that paper the wheatbelt was divided into three zones, according to the annual rainfall and for convenience, some of the tables and comments have been included herewith.

The three zones and the Road Board districts included in each are:—

Zone 1.	*Zone* 2.	*Zone* 3.
Under 14 *in.*—	14–18 *in.*—	18·20 *in., and above.*—
Mukinbudin	Northam	Greenough
Mullewa	Northampton	Irwin
Morawa	Upper Chapman	Moora
Perenjori	Geraldton	Victoria Plains
Dalwallinu	Mingenew	Toodyay
Dowerin	Three Springs	York
Wyalkatchem	Carnamah	Brookton
Koorda	Wongan-Ballidu	Cuballing
Mt. Marshall	Goomalling	Narrogin
Westonia	Meckering	Wagin
Nungarin	Corrigin	Katanning
Merredin	Kulin	Broomehill
Kellerberrin	Quairading	Tambellup
Kununoppin	Wickepin	Woodanilling
Bruce Rock	Dumbleyung	Esperance
Narembeen	Kent	(Southern 1/3)
Kondinin	Beverley	
Lake Grace	Pingelly	
Yilgarn	Gnowangerup	
Dundas	Esperance (Northern 2/3)	

In addition to obtaining a good sample of grain for seed purposes it is essential that each variety should be planted during the appropriate period for its maturity.

The following table has been compiled from collected statistical data and gives the proportionate planting for each maturity in each zone.

Cereal.	ZONE 1. Early. Under 14 in. Rainfall. Chiefly Wheat.		ZONE 2. Midseason. 14 in. to 18 in. Rainfall. Wheat and Sheep.		ZONE 3. Late. 18 in. to 20 in. Rainfall. Sheep and Wheat.	
	Proportion.	Maturity.	Proportion.	Maturity.	Proportion.	Maturity.
Wheat ...	2/3	Midseason ...	4/5	Late and midseason	9/10	Late and midseason
	1/3	Early and very early	1/5	Early and very early	1/10	Early and very early
Oats	1/3	Midseason ...	2/3	Late and midseason	3/4	Late and midseason
	2/3	Early and very early	1/3	Early and very early	1/4	Early and very early
Barley ...	...	Early (fodder)	...	Early (malting), Early (fodder)	...	Early (malting), Early (fodder)

Seeding calendars have also been prepared for each zone covering the recommended varieties and their appropriate planting periods. (Figs. 2, 3, 4.)

It must be mentioned here that the indicated planting periods should be used as a guide with due regard to local conditions, as it will be appreciated that it is not possible to give specific recommendations for individual districts within a zone.

With all cereal plantings it is desirable that the seeding programme commence with the latest maturing variety being planted and be completed with the earlier maturing ones. For maximum yields it is not generally advisable to extend the planting periods for various maturities beyond those indicated. It is very desirable, however, that sufficient seed of both early and mid-season varieties be reserved and kept on hand in order that, if necessary, the areas sown to each can be adjusted to meet seasonal conditions.

With regard to the planting of cereals for green fodder (Cariss 1945), these are normally sown as early as possible in the season, irrespective of the maturity of the variety being used. In this connection the cereal varieties recommended are:—

Oats:

Algerian.—Late maturing (high rainfall areas particularly).

Dale.—Mid-season maturing.

Fulghum.—Mid-season maturing (standard grazing oat).

Ballidu.—Early maturing.

Wongan.—Very early maturing.

Barley:

Atlas.—Early maturing (very satisfactory).

WHEAT VARIETIES.

With regard to maturity standards it is customary in Western Australia to classify wheat varieties into four standard maturity groups relative to the control variety, Gluyas Early:—

(i) Very early maturing—flowering five or more days earlier than Gluyas Early.

(ii) Early maturing—flowering four days earlier to three days later than Gluyas Early.

(iii) Mid-season maturing—flowering four to nine days later than Gluyas Early.

(iv) Late and late mid-season—flowering ten or more days later than Gluyas Early.

The following are short descriptions of the recommended varieties which are at present being produced as pedigree seed:—

Mid-season Varieties.

Kondut.—Bred at the Wongan Hills Light Lands Research Station, Kondut, has yielded well, over a wide range of soil and climatic conditions.

Although not rust resistant, it gives better yields under epidemic conditions than Benecubbin and Nabawa. It is resistant to flag smut.

The straw is stout and the variety can be recommended for early planting, particularly on light land and in rust liable districts.

Kondut yields flour which is usually superior in strength to that of the f.a.q.

Eureka.—This variety was bred in New South Wales as a resistant wheat for planting in rust liable districts. A new rust strain has, however, appeared in New South Wales to which Eureka is susceptible. This race has not yet been collected in Western Australia.

Eureka is a stout strawed rather tall growing brown chaffed variety with translucent grain. Under slow ripening conditions the grain frequently mottles. The flour strength of Eureka is well above the f.a.q. of the State. It is resistant to flag smut. The desirable planting date for Eureka in each district would be about the same as for Bencubbin.

Bencubbin.—The standard mid-season wheat which is the most extensively grown variety in Western Australia and also Australia. The straw strength tends to be weak on light land but is satisfactory for hay. Bencubbin is notable for its high yields under inferior seasonal conditions. and although very susceptible to rust is resistant to flag smut. Its flour strength is equal to the State f.a.q.

Early Maturing.

Koorda.—A relatively recent release by the West Australian Department of Agriculture, Koorda has yielded well on the lighter soils where its strong straw is of great value. Koorda is practically immune to flag smut and tends to be rust escaping in all but the heaviest epidemics. The flour strength of Koorda is about the same as that of the f.a.q. standard.

In yield trials on the Research Stations, Koorda has outyielded Merredin a variety which it has been designed to replace.

Very Early Maturing.

Bungulla.—The standard early maturing variety and a selection from Bencubbin. Like Bencubbin is notable for its high yields, particularly under low rainfall conditions.

Because of its early maturity, it usually suffers relatively little rust damage. The straw strength is satisfactory on the heavier soil types, but Koorda is to be preferred on light soils in all but the drier districts.

Bungulla is satisfactory for hay whilst the flour strength is equal to the f.a.q. of the State. It is resistant to flag smut but not to rust.

Charter.—Released in 1944 by the New South Wales Department of Agriculture. Bred by S. L. Macindoe from a cross made at the Glen Innes Experiment Farm in 1931, between a selection of Kenya C6040, resembling C6042 in rust reaction, and Gular.

Highly resistant to all Australian races of stem rust and to flag smut. The straw is tall and though of good quality is apt to lodge when yields are high.

Grain mottles less than Eureka and is of better flour strength, reaching the premium class.

Hay Variety.

The variety Baroota Wonder is grown almost exclusively for hay. It is a relatively tall growing wheat and remains green to the base until haycutting time. It is very susceptible to loose smut and rust, but moderately resistant to flag smut.

Premium Varieties.

The premium wheats have received this name because in the past millers have paid a premium for them, an extra price over and above f.a.q. prices. Millers have paid these prices because it was considered that the ordinary f.a.q. wheats

gave a flour too weak for the local breadmaking trade and it was thus necessary to blend in some strong or premium wheat flour to build up the f.a.q. varieties to the strength required by the local trade.

From the farmer's point of view the premium wheats yield less bushels per acre than do the f.a.q. varieties. and it is a matter of economics as to whether the increased price, based on the strength of the premium variety, compensates the grower for the decreased yield.

Since in this State the variety Comeback is normally stronger than Pusa IV. when grown under the same conditions it usually commands a higher premium.

In discussing the strength of wheat it must be remembered that soil, district and climate affect this factor not only for the premium varieties, but also for the f.a.q. varieties discussed above. In general, heavy soils yield stronger wheats than do light soils and also the harder the growing conditions the stronger the wheat produced.

Comeback is an early maturing variety which generally gives yields of about two-thirds that of the f.a.q. varieties grown under identical conditions. It is resistant to flag smut and is usually rust escaping.

Pusa IV. is more prolific than Comeback. It grows very vigorously and matures early. Pusa IV. is resistant to flag smut but not to rust, although it usually escapes major damage.

OAT VARIETIES.

Oats are notoriously difficult crops to harvest for grain, particularly following adverse weather conditions, and plant breeders therefore, have been particularly concerned with straw strength and non-shedding. The W.A.-bred oat varieties, Dale, Ballidu and Wongan, represent a notable achievement in respect to improved straw strength and ability to withstand unfavourable weather. These three varieties are selections made by Mr. D. R. Bateman at the Wongan Hills Research Station from a Mulga-Burt's Early cross and they fulfil the requirements of a general purpose oat. They are suitable for grain and hay and also for early green grazing and recovery. With their differing maturities they cover the range of the planting season.

Oats are classified as to maturity in much the same manner as are wheats:—

Very Early Maturing: Flowering four or more days earlier than Mulga.

Early Maturing: Three days earlier to six days later than Mulga.

Mid-season Maturing: Seven to fourteen days later than Mulga.

Late Maturing: Fifteen or more days after Mulga.

Oats are being increasingly used as a source of early green feed. They are sown either on fallow or stubble land in early April and fed off six to eight weeks after the opening rain of the season. Varieties vary considerably in their suitability for this purpose both in respect to the quantity of green feed produced and in their ability to recover after grazing.

Oats are used extensively for hay for which purpose the leading varieties are well suited. The present oat breeding programme aims at the development of varieties combining large grain size and straw strength and the retention of the long juvenile phase of Fulghum in a stronger strawed variety.

The following are short descriptions of the recommended varieties which are at present being produced as pedigree seed:—

Late Maturing.

Algerian.—The standard late general purpose oat which is cultivated chiefly in the Great Southern areas of the wheat belt. It is also used extensively for oatmeal manufacture.

Mid-season Maturing.

Guyra.—The standard mid-season variety which is notable chiefly for its plump grain. Although a popular hay variety the straw tends to be very coarse under favourable conditions of growth and lodging frequently occurs where crops are left for grain. Guyra is an indifferent variety for grazing and recovery since the early growth is relatively sparse and the grain yields, subsequent to grazing, only fair.

Fulghum.—The standard grazing and recovery oat, but is not a good general purpose variety as the straw strength is very poor. Fulghum is used principally for grazing and recovery since the notable length of its leafy growth phase prior to "shooting" enables it to be grazed later in the season than other mid-season varieties. As a grazing oat the initial growth is not as vigorous as that of Dale but it is, however, very suitable for late winter or early spring feed.

The grain of Fulghum is suitable for oatmeal manufacture.

Dale.—This has given satisfactory results as a general purpose variety under a wide range of conditions. It is markedly superior to other mid-season varieties in respect to straw strength and is very suitable for early grazing.

Early Maturing.

Ballidu.—The standard early oat which has demonstrated its general superiority to Mulga in trials on research stations and is proving very satisfactory on farmers' holdings. The straw strength and grain yields are outstanding whilst its vigorous leafy early growth and satisfactory recovery make it suitable for grazing and recovery.

Very Early Maturing.

Wongan.—The standard very early maturing oat which is notable for its vigorous early growth and strong straw. It is satisfactory as a hay variety although it is often rather short strawed. As a grain variety, it stands well but tends to shed if left unharvested too long after it has matured.

The vigorous early growth makes Wongan a suitable variety for early winter feed, but it cannot be grazed as late in the season as Ballidu and the mid-season varieties if recovery for grain is desired.

BARLEY VARIETIES.

Barleys are normally classified as being either two-row or six-row types and according to their suitability or otherwise for malting.

Suitable malting barleys are found both in the two-row and six-row types, but local maltster's technique is based upon the use of the two-row types. Prior to the outbreak of war there was an expanding export of six-row malting types to the United Kingdom, but this has, owing to shipping and other difficulties, been temporarily suspended.

The selection of barley varieties for seed depends, therefore, upon the purpose for which the crop is to be grown. Practically all varieties in cultivation in Western Australia are early maturing and therefore the planting date will be dependent upon whether the crop is to be used for malting grain, fodder grain or green feed.

Barley for malting purposes is usually seeded during the latter half of May. When grown as a feed grain it is planted when convenient, usually after the wheat and oats have been sown. Barley for green grazing is customarily sown in April.

Description of the two recommended varieties are:—

Atlas.—A six-row malting type barley introduced from California. It is also known in this State as Californian six-row barley. It is used in England for malting purposes in the production of light sparkling bottle beer and prior to the war exports of suitable samples were increasing substantially. This barley is also eminently suitable for early green feed for which purpose it is at present mainly grown; a small quantity is used for malting locally in order to maintain a nucleus of the industry. It is very suitable also for feed grain purposes, being superior in yielding capacity to Cape. The results of trials with this typical six-row barley indicate that it is superior to oats as a source of early green feed, particularly at the time of the first grazing.

Prior.—A two-row barley which is the most important malting variety grown in the Commonwealth. Although it is generally considered that Prior is a strain of English Archer malting barley, there is no record of the variety from which it actually originated or the methods by which it was developed. This variety, which proved to be much more prolific and superior in malting quality to other malting barleys, was named after Mr. Samuel Prior, of Brighton, South Australia, who obtained one bag of seed of unknown origin from an Adelaide seedsman in 1900. It was from this seed that the strain was developed, Messrs. Barrett Bros., maltsters of South Australia, being responsible for its initial distribution. Prior is also a useful variety for green fodder purposes.

PURE SEED DISTRIBUTION.

As mentioned earlier the production of pedigree seed is a major function of the Wheatbelt Research Stations and over the past ten years approximately 4,000 bags of pedigree wheat, oats and barley seed has been made available to farmers annually.

For distribution from the current harvest it is anticipated that seed of the recommended varieties described earlier in this paper will be available.

The general policy of the distribution scheme is to supply as many farmers as possible with small quantities of seed to establish their own "stud" plots and therefore it is usually necessary to limit the number of bags of any one variety supplied to each applicant, and on some occasions to limit the number of varieties.

The conditions of purchase for the current season will be that the seed will be supplied on a *cash basis only*.

The cash prices for wheat, oats and barley, inclusive of rail freight to applicant's siding, will be:—

	per bag of 3 bushels.
Wheatbelt Areas—	
Wheat and Barley	22s. 6d.
Oats	15s.
South-West Areas—	
Wheat and Barley	22s. 6d.
Oats	16s. 6d.

In order to avoid disappointment in obtaining their requirements, farmers will assist considerably by noting the following directions:—

(1) All applications should be made *direct* to the Department of Agriculture, Perth.

(2) Applications should include the full name and postal address of the applicant and also the *siding* to which he desires the seed to be railed.

(3) Make early application.

(4) Forward cash remittance as soon as possible after receipt of statement of account. Statements of account are sent out in order of receipt of application.

(5) No definite reservations can be made until after receipt of the necessary cash remittance.

SEEDING CALENDARS.

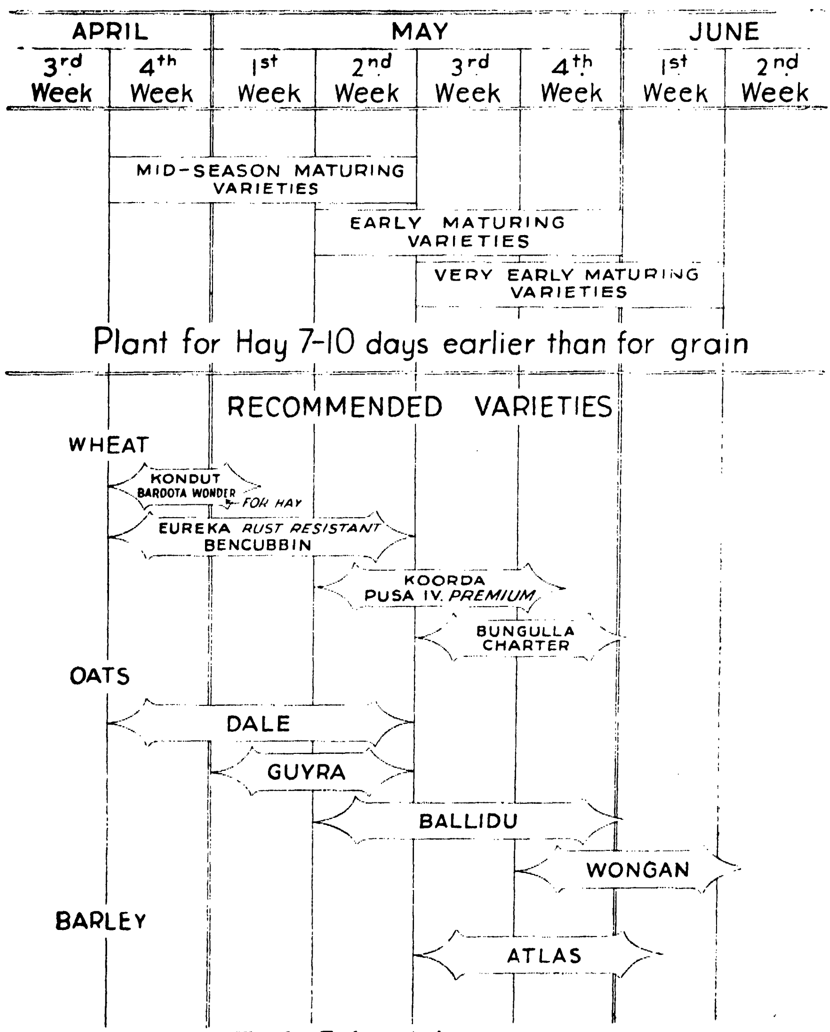

Fig. 2.—Early maturing zone.

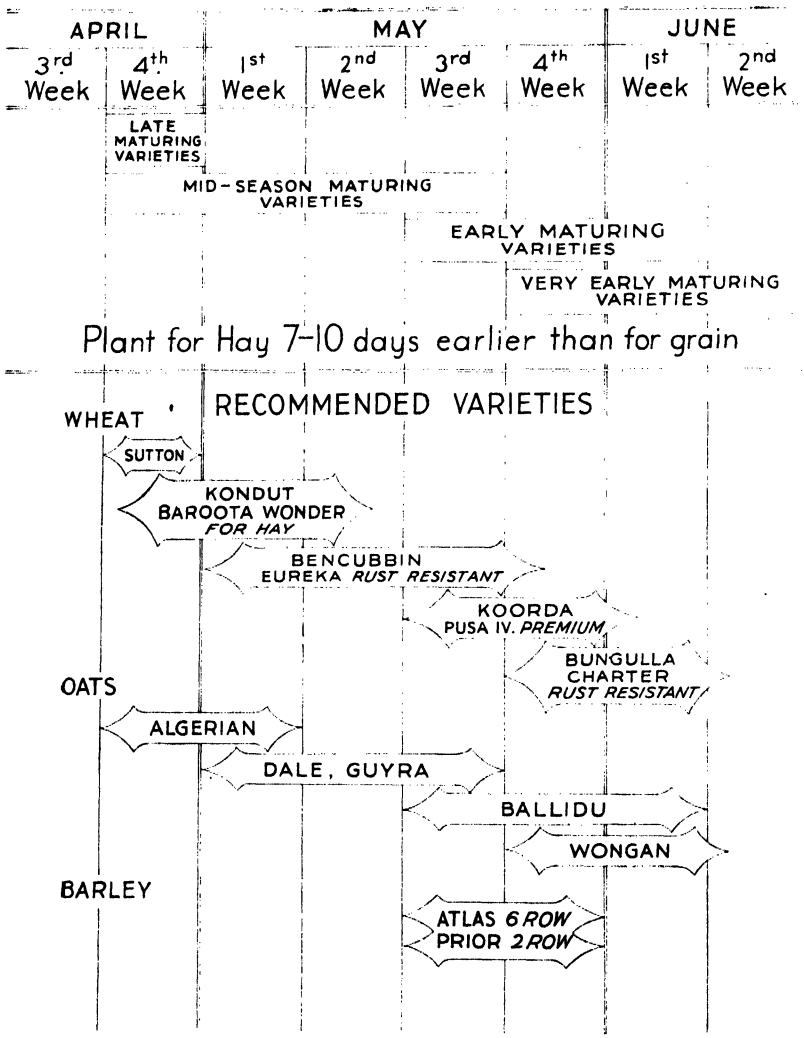

Fig. 3.—Mid-season maturing zone.

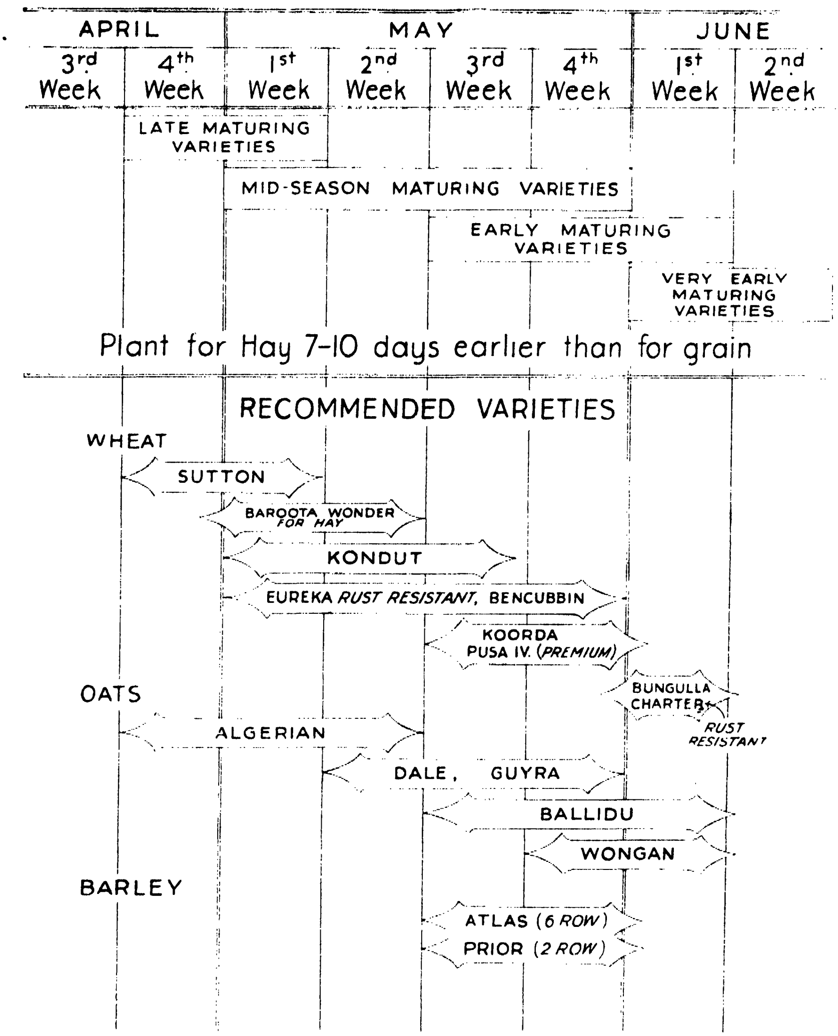

Fig. 4.—Late maturing zone.

ACKNOWLEDGMENT.

The authors are indebted to the Chief Draughtsman, Lands Department, for the drawing of the figures.

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Samuel, L. W.: "Areas sown to individual varieties of wheat in Western Australia." Jour. Agric. West. Aust. 22. 2nd series, 293-294.

Thomas, I., Millington, A. J., and Cariss, H.G.: "The utilisation of cereals in Western Australia." Jour. Agric. West. Aust. 21. 2nd series, 206-226.

The following additional Fertilisers have been Registered at the Department of Agriculture under the Fertiliser Act, 1928, for the Year commencing 1st November 1945.

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered.	Nitrogen (N) as				Phosphoric Acid (P_2O_5) as				Potash (K_2O) as		Cash Price per ton on rails at Works† or Perth.‡
				Nitrate.	Ammonia.	Blood and Bone	Bone-dust	Water Sol.	Citrate sol.	Acid sol.	TOTAL	Sulphate.	Muriate.	
				%	%	%	%	%	%	%	%	%	%	£ s. d.
1.—*Nitrogen Phosphoric Acid and Potash.*														
Potato Manure "A"	70	Sickle	Cuming Smith & Mt. Lyell F.F. Ltd.	....	2·50	....	....	10·00	1·75	1·25	13·00	5·00	....	9 15 11†
Do. "B"	71	do.	do. do.	....	3·50	....	....	9·50	1·50	1·25	12·25	5·00	....	10 8 3†
Do. "A"	72	C.S.M.L.	do. do.	....	2·50	....	....	10·00	1·75	1·25	13·00	5·00	....	9 15 11†
Do. "B"	73	do.	do. do.	....	3·50	....	....	9·50	1·50	1·25	12·25	5·00	....	10 8 3†
Do. "A"	74	ML in diamond	do. do.	....	2·50	....	....	10·00	1·75	1·25	13·00	5·00	....	9 15 11†
Do. No. 3	75	do.	do. do.	....	3·50	....	....	9·50	1·50	1·25	12·25	5·00	....	10 8 3†
Orchard Manure	63	Cresco	Cresco Fertilisers (W.A.), Ltd.	5·00	....	....	....	7·00	1·25	·75	9·00	....	9·80	14 8 11†
2.—PHOSPHATIC.														
Superphosphate	64	Sickle	Cuming Smith & Mt. Lyell F.F. Ltd.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
	65	ML in Diamond	do. do.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
	66	C.S.M.L.	do. do.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
	68	Cresco	Cresco Fertilisers (W.A.), Ltd.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
ORGANIC.														
(*a*) *Blood and Bone*	67	Wyndham	Wyndham Freezing, Canning and Meat Export Works	....	....	5·75	....	....	6·00	9·00	15·00	....	....	10 12 6‡
MISCELLANEOUS.														
(*c*) *Fish Fertiliser*	69	Cormo	Norwest Fertilisers	....	....	5·00		....	....	8·00	8·00	....	....	On application.

The following Amendments to the list published in the December Journal 1945 have been Registered.

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered.	Nitrate.	Ammonia.	Blood and Bone	Bone-dust	Water Sol.	Citrate sol.	Acid sol.	TOTAL	Sulphate.	Muriate.	Cash Price
Sulphate of Potash	59	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	....	....	....	....	....	....	....	30·00	....	16 13 0
Potato Manure "C"	22	Sickle	do. do.	....	3·50	....	....	11·75	2·00	1·50	15·25	....	....	8 8 10†
Do. No. 2	32	ML in Diamond	do. do.	....	3·50	....	....	11·75	2·00	1·50	15·25	....	....	8 8 10†
Do. "C"	41	C.S.M.L.	do. do.	....	3·50	....	....	11·75	2·00	1·50	15·25	....	....	8 8 10†
Tomato Manure	48	do.	do. do.	....	3·50	....	....	10·00	1·50	1·25	12·75	....	8·00	11 18 6†
Tobacco Manure No. 5	49	do.	do. do.	2·80		....	....	11·25	1·75	1·35	14·35	2·50	....	9 1 8†
Orchard Manure	60	Sickle	do. do.	5·0	....	....	....	7·50	1·25	0·75	9·50	....	9·80	14 8 11†
Do.	61	C.S.M.L.	do. do.	5·0	....	....	....	7·50	1·25	0·75	9·50	....	9·80	14 8 11†
Do.	62	ML in Diamond	do. do.	5·0	....	....	....	7·50	1·25	0·75	9·50	....	9·80	14 8 11†
												Copper Oxide		
Superphosphate and Copper Ore	26	"Florida"	do. do.	....	....	....	....	12·30	2·00	1·50	15·80	1·60		7 8 4†
Do. do. do.	45	C.S.M.L.	do. do.	....	....	....	....	12·30	2·00	1·50	15·80	1·60		7 8 4†

Sheep Yards at Research Stations.

I. THOMAS, Superintendent of Wheat Farming.

H. G. CARISS, Agricultural Adviser.

INTRODUCTION.

WITH the carrying of sheep on wheatbelt farms assuming greater importance, the question of the erection of compact and efficient sheep drafting yards must receive attention. Consideration must also be given to the provision of suitable facilities for shearing and the construction of a sheep dip.

It is desirable that sheep yards, shearing shed, and sheep dip be a compact workable unit. If it is not possible for the main yards to be constructed in association with the shearing shed, then a small set can be erected as has been the case at the Salmon Gums Research Station.

Generally speaking, when planning sheep yards it is better to err on the larger side and make provision for the handling of a greater number of sheep than is actually required at the moment.

Sheep yards are either rectangular or circular in construction, the latter type being erected at all the wheatbelt research stations, and in this paper, the design and construction of several of the research station yards are described and illustrated.

Plans and specifications for a set of circular yards capable of handling 1,000 to 1,500 sheep are included and the methods of construction discussed (Figs. 9 & 10).

THE CONSTRUCTION OF SHEEP YARDS.

Irrespective of whether the yards are rectangular or circular in design there are a number of salient factors to be taken into consideration in their erection.

(i) For the most efficient handling of sheep at all times of the year, it is essential that such yards be compact and well laid out. They should also be constructed so that, when the occasion arises, any sheep can be manhandled with the minimum amount of exertion by the operator, and least harm to the sheep.

(ii) As the design and layout of sheep yards can be made to conform with any existing buildings which may be utilised for shearing or crutching, any extra gates and races should be provided for in the initial layout (Fig. 10).

(iii) The drafting race should be constructed so that one side is in line with the centre fence through the yards, the reason for this being, that should a stoppage occur whilst drafting, the gate can be so swung that the leading sheep has an uninterrupted view of those already in the check pen (Fig. 1).

(iiia) The gates from the branding race should be so arranged to permit of ease of operation with least interruption to the movement of the sheep from the race and also between the receiving yards (Fig. 11).

(iv) The height of the posts, which should not be more than 6ft. apart between centres, is 3ft. 6in., and they should be at least 2ft. in the ground. The posts themselves may be of sawn timber, bush timber or concrete. Old condemned sleepers are not usually recommended as they tend to rot more readily than new timber. With concrete posts care must be taken that they are sufficiently well

reinforced. When bush timber is used, and sufficiently large posts are not available, then it is advisable to use two individual posts for each panel, making each a separate unit (Fig. 2).

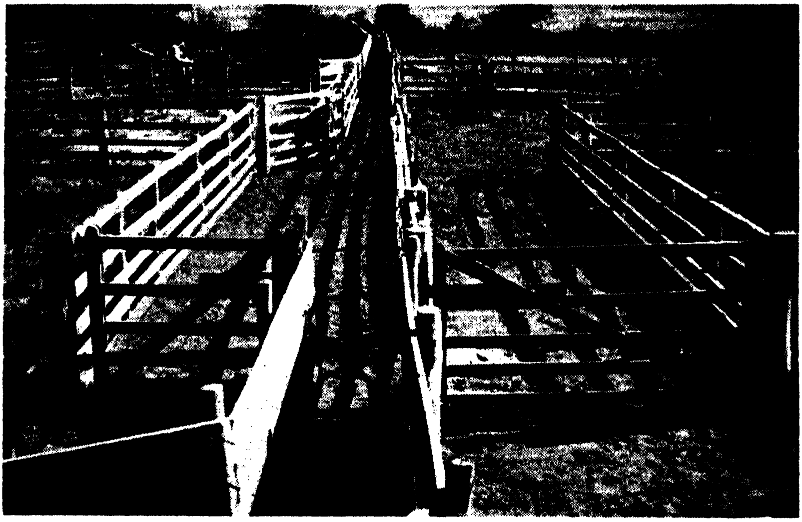


Fig. 1.—Drafting race and check pens as at Wongan Hills Research Station.

Fig. 2.—Individual fence panel of bush timber as at Salmon Gums Research Station.

(v) The joins of the rails should be butted not lapped and the bottom rail not more than 3in. from ground level. For preference the rails should be laced on with wire (Figs. 2 and 12). It will be noted that, with the boards, only one hole through the board near the top is needed and with the "bush" timber rails, only the end ones need to be bored. With any type of rail the use of too many holes should be avoided.

(vi) When available, the timber most suitable for the rails is 6in. x 1in. jarrah, with four rails per panel. When "bush" (unsawn) timber is used five rails per panel are required, and, for durability, they should be not less than 2in. in diameter at the small end (Figs. 2 and 12).

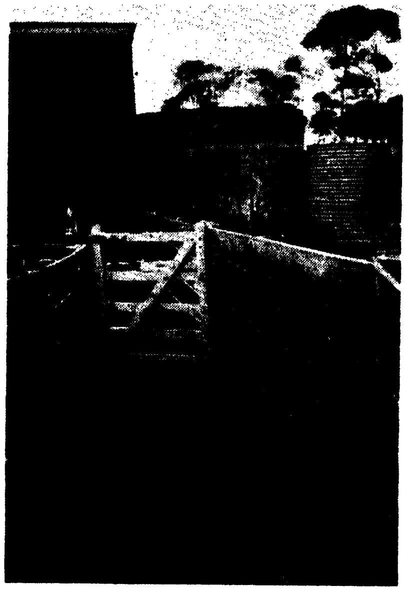


Fig. 3.—Entrance to drafting race (left centre) showing close-boarding of crush. Salmon Gums Research Station.

(vii) It is desirable that the latter part of the crush pen as well as the race be close boarded with 6in. x 1in. jarrah (Fig. 3).

(viii) As gates are a most important feature of all sheep yards, particular attention should be paid to their construction. They should be reasonably light but sufficiently strong to withstand normal wear and tear. The gates, themselves, should be either all metal or of sawn timber. The sawn timber type of gate is usually made out of 3in. x 1in. or 4in. x 1in. full dressed karri or wandoo timber, and of five-bar construction (Fig. 13).

(ix) Gates should be so placed that the sheep can be readily returned to the crush pens for redrafting if required. They should, wherever possible, be swung so as to follow the main movements of the sheep through the yards.

(x) The actual width of the gate-way, of course, must be such as to allow for the hinges and gudgeons and therefore for convenience the gates could be hung before construction of the fence panels.

(xi) The centre type double strap hinge and gudgeon will generally be found the most useful, as this type allows full freedom of swing to the gates.

(xii) To assist the trucking of sheep to market, etc., it is of advantage to include pens of a capacity equal to at least one deck of a small railway sheep

truck. The check pens (Fig. 9) hold approximately 40 woolly sheep each, which is the capacity of one deck of a small truck. The average capacities of the various types of railway trucks are as follows:—

Truck.	Woolly Sheep.	Spring Lambs.
C	70-75	90
CXA	80	100
S	140-150	180
SX	160	200

CIRCULAR SHEEP YARDS.

Though the design and construction of the circular type sheep yard is not new, it has been found to be most convenient for handling both large and small flocks of sheep, and as a result of experience gained over a number of years, some improvements have been made.

The circular type of yard has the merit of being compact and convenient for handling sheep, irrespective of whether the whole or only a portion of a farmer's flock is to be handled at the one time. One of the many advantages is the ease with which the sheep in the inner yards can be handled, including redrafting if necessary, without interfering with the sheep in other yards.

The main features of this type of yard are the inner and outer circles which are so arranged that both form part of the crush to the drafting race. The width of the crush pen may be altered very simply by changing the distance between the centres of the two circles.

A reduction or increase in the capacity of the yards is achieved by increasing or decreasing the radii of the two circles. This necessitates also, the increasing or decreasing of the distance between the two centres so that the width of the crush pen, as it enters the drafting race, remains the same. Therefore, to increase the size of the outer yard, the centre of that circle would be moved towards the point "S" (Figs. 9 and 10), and the same procedure would apply to the enlarging of the inner yards. The usual practice for determining the capacity of sheep yards is to allow 4 square feet per sheep.

Before commencing the actual construction, it is as well to lay out the yards first by placing pegs at the two centres, marking the circles on the ground with a mattock or pick, and placing pegs to indicate the corners and gateways (Fig. 10). By doing this a rough outline of the general design of the yard can be seen and any adjustments to advantage made.

It will be noted, also, that provision is made for utilising the crush pens to the drafting race in conjunction with the race leading to the sheep dip.

The estimated quantity of 6in. x 1in. sawn timber, required for construction of these yards is set out below:—

Total length of fencing, exclusive of race to dip	=	850ft. approx.
= say 142 panels each 6ft. @ 24ft. per panel	=	3,408ft. approx.
Extra boarding for race and crush	=	180ft. approx.
		3,588ft. approx.

With "bush" timber a minimum of 700 6ft. rails will be required. In addition approximately 420 ft. of 6in. x 1in. jarrah will be needed for the close boarding of the race and crush pen. Provision should be made for approximately 200 posts, inclusive of gate posts; this quanti y would need to be increased when the smaller posts are used.

YARDS AT THE RESEARCH STATIONS.

1. *Wongan Hills Research Station.*

The plan of the yards at this station includes the dip and shearing shed layouts. It will be noted (Figs. 1 and 14) that the dip is situated on the opposite side of the yards to those already described. The sheep to be dipped pass through the drafting race, check pen, branding race and then through a moveable race to the ramp at the entrance of the dip. Having the dip in this position has been found to be rather unsatisfactory and it is suggested that the dip be located as on the main plan (Fig. 9).

The shed is a combined barn and shearing shed, and therefore, to enable the whole to be used for storage, the fittings for the pens have been made removable and are stored away when not in use.

For ease of branding after shearing, it might be desirable to have a race in the yard into which the sheep are counted (Figs. 4 and 14).

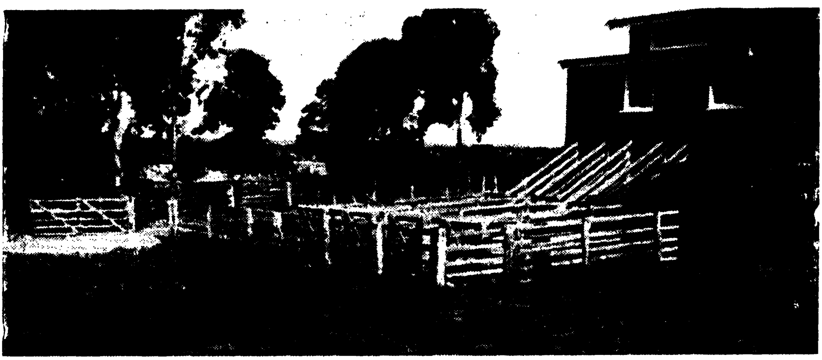


Fig. 4.—Counting out pens as at Wongan Hills Research Station.

With these yards the inner or main working yards and crush pen were constructed with timber rails, 3in. x 1½in. rough jarrah being used with five rails per panel and the last few panels of the crush pen and the race close boarded with 6in. x 1in. jarrah boards (Fig. 1). For the outer and receiving yards 3in. x 36in. marsupial netting on an ordinary 6-wire fence was used.

The use of the netting fencing reduces the cost quite considerably but the all-timber construction is preferred on account of durability.

2. *Salmon Gums Research Station.*

The yards at this station, with the exception of the race and crush pen, are constructed wholly of "bush" timber (Figs. 5 and 6). The individual fence panels have been treated as separate units as it was considered that this method would make a stronger and more satisfactory job than if single posts were used (Fig. 2). Except where essential the rails have not been bored for the fastening wires.

At this station, also, a set of yards have been constructed alongside the shed used for shearing. The plan of these yards and the sheep pens in the shed have been included (Figs. 7, 15 and 16), for the information and guidance of a farmer who may have a similar type of shed. The gratings and shearing boards are removable for cleaning and storage, and, if desired, could be procured ready-made

in suitable sizes from the timber merchants. As will be seen (Fig. 7) the small set of yards which is capable of handling 400-500 sheep, is constructed with sawn timber.

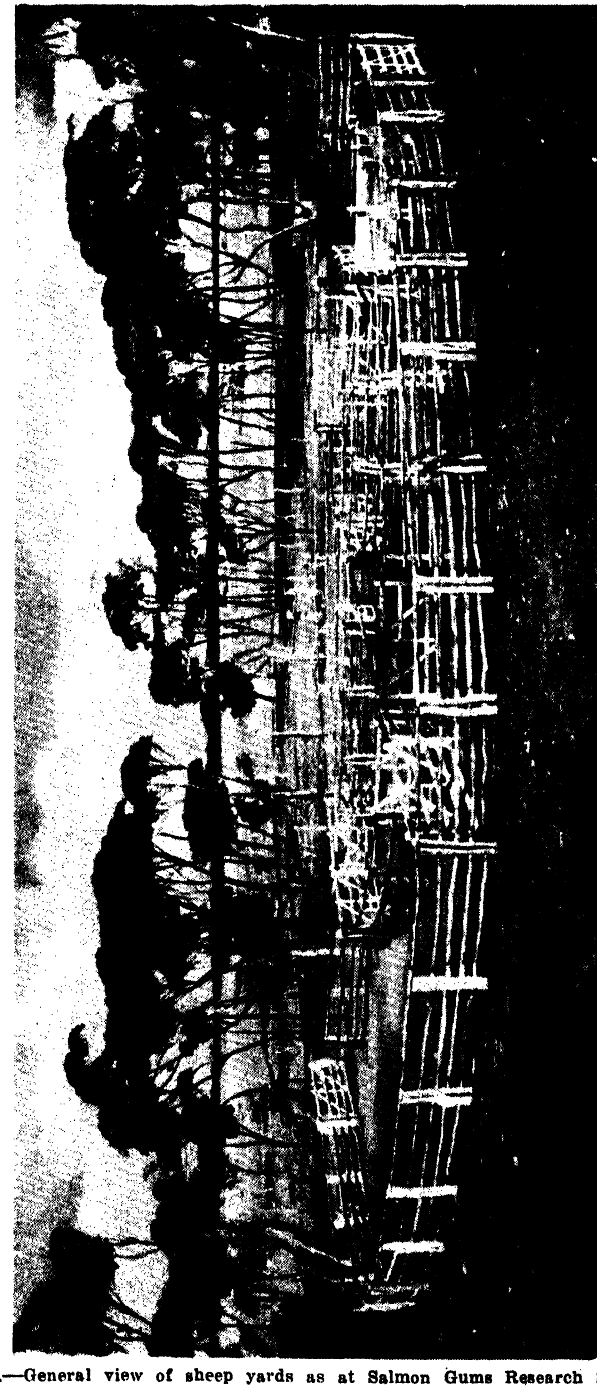


Fig. 5.—General view of sheep yards as at Salmon Gums Research Station.

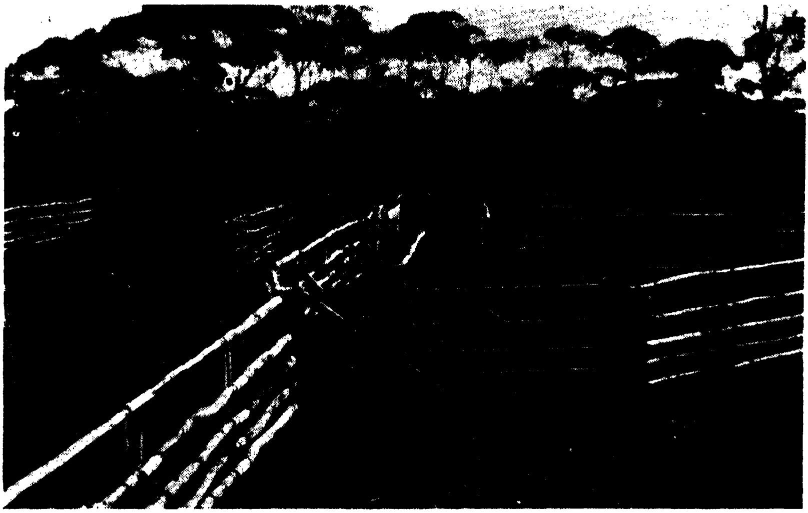


Fig. 6.—Inner receiving yards, Salmon Gums Research Station.

Fig. 7.—General view of shearing shed yards at Salmon Gums Research Station.

3. *Avondale, Chapman and Merredin Research Stations.*

The yards erected at the Avondale, Chapman and Merredin Research Stations are practically identical in design and though no layouts are included the following comments are of interest:—

At Avondale the ramp to the dip has been so constructed that it can also be used for the loading of sheep and fat lambs on to motor trucks. The branding race is also used when weighing the export lambs and other sheep, the scales being placed at the end farthest from the drafting race.

At Merredin (Fig. 8) the square type catching pen for the dip is at present erected, but it is intended, however, to replace this with the circular type.

Fig. 8.—Sheep dip at Merredin Research Station.

SHEEP DIPS.

As the dipping of sheep in the agricultural areas is compulsory, it is desirable that provision be made for a suitable type of dip in association with the sheep yards.

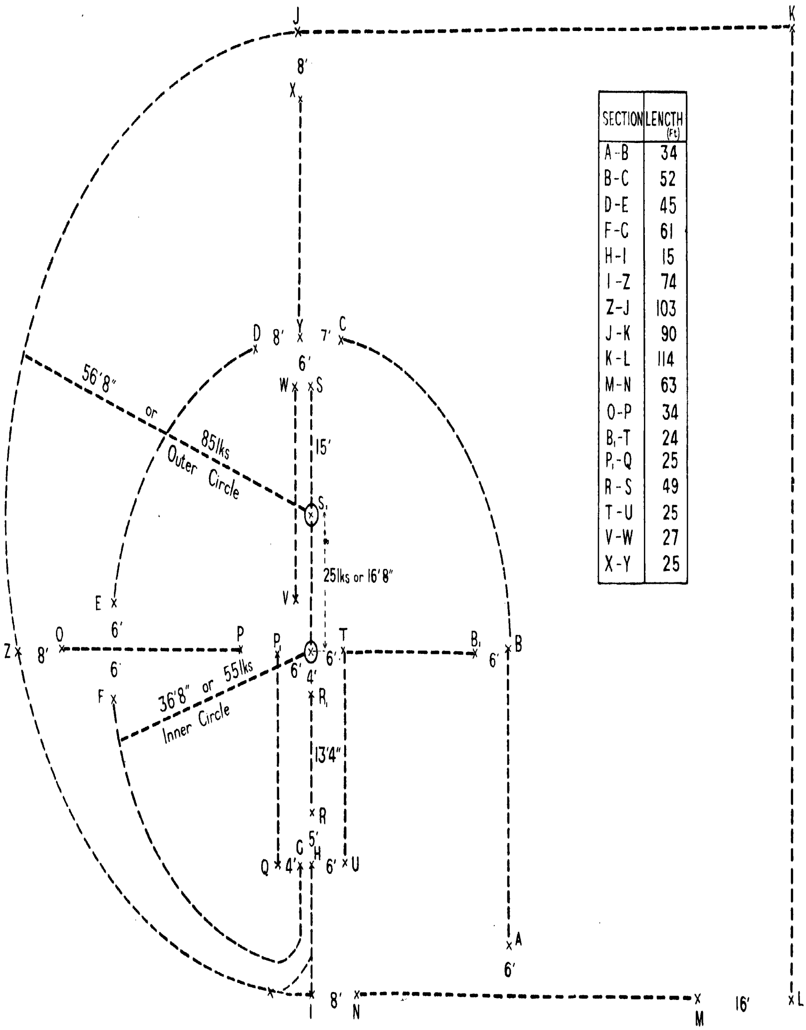
Plans for a suitable dip have, therefore, been included in this paper (Figs. 17, 18 and 19). The following main points should be noted:—

1. The minimum length of the dip should be 30ft. including a 10ft. walk out.
2. The depth of dip to water level be 5ft. and 5ft. 6in. overall. The dip to be 20in. wide at the top and 9in. at the bottom. It is of advantage if the floor of the dip is sloped to one end with say a fall of 1in. to 10ft. to assist cleaning out.
3. The walls of the dip be constructed of 4in. of concrete with a 9in. cap.
4. Suitable dimensions for the two draining pens are 12ft. x 12ft. each.
5. The race to the catching pen should be narrow, i.e., not more than 20in. wide (inside measurement).

Three different types of entrances to the dip are included, namely, the elevated ramp, the square catching pen and the circular catching pen (Figs. 9 and 20) and require little additional comment. With regard to the circular type, however, this appears to be most suitable for a farmer, as two men on their own can, if necessary, dip the sheep quite conveniently. With this type the sheep can be kept up to the catcher by the movement of one of the gates by the second man. Fig. 20 shows the layout of the pen, dip and draining pens, and Fig. 21 the design and method of swinging the two gates. The most suitable post for the purpose is possibly a piece of 4in. wrought iron water-pipe, an ordinary wooden post could be adapted, but it would need to be of not less than 6in. in diameter at the small end.

ACKNOWLEDGMENTS.

The authors are indebted to the Assistant Superintendent of Wheat Farming (Mr. F. L. Shier) and other officers of the Wheat Branch for their advice, criticism and assistance in the preparation of this paper and to the Chief Draughtsman, Lands Department, for the drawing of the plans.



SECTION	LENGTH (Ft)
A-B	34
B-C	52
D-E	45
F-G	61
H-I	15
I-Z	74
Z-J	103
J-K	90
K-L	114
M-N	63
O-P	34
B1-T	24
P1-Q	25
R-S	49
T-U	25
V-W	27
X-Y	25

Fig. 10.—Method of setting out plan of circular yards (see text).

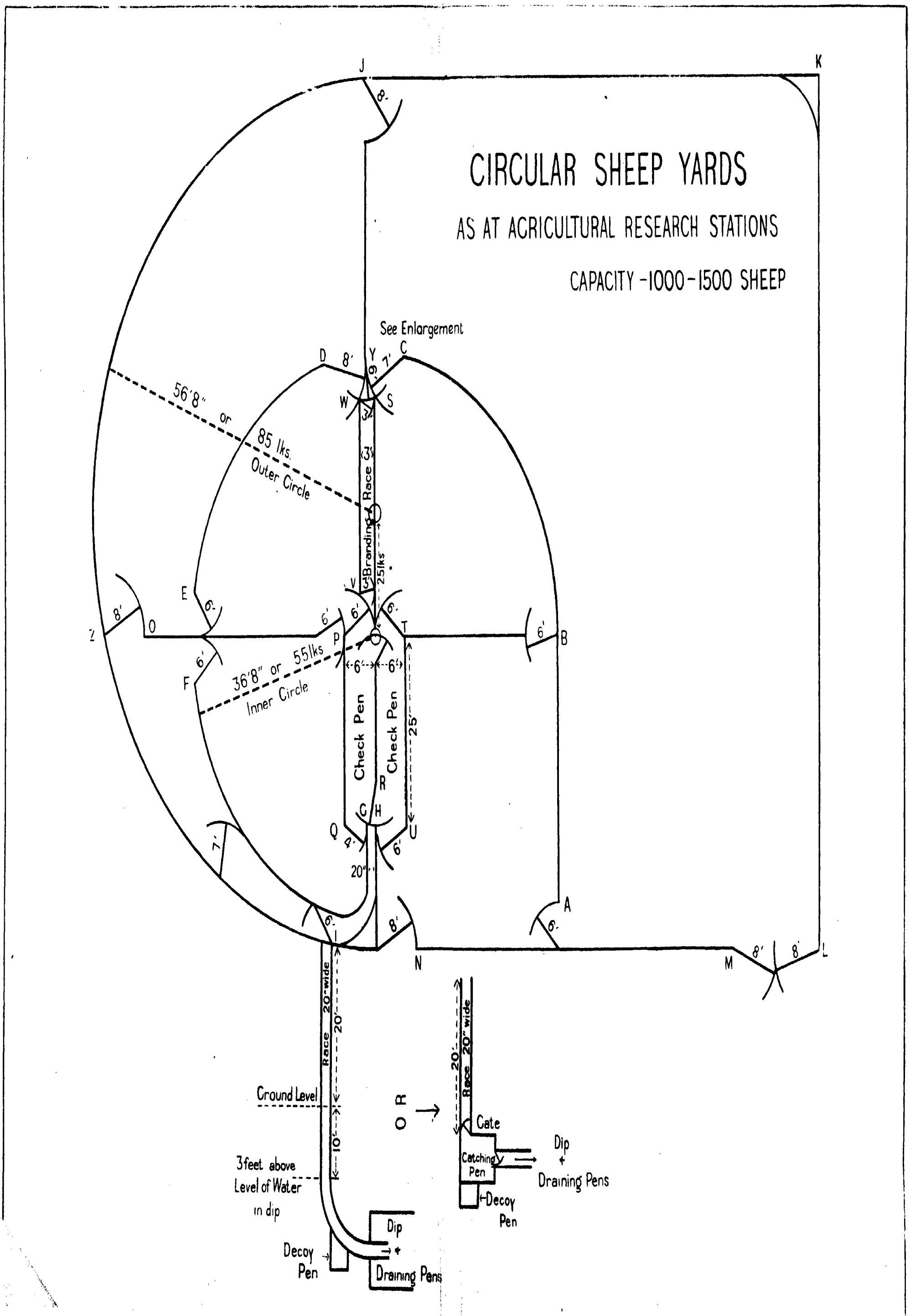


Fig. 9.—Layout of circular type sheep drafting yards.

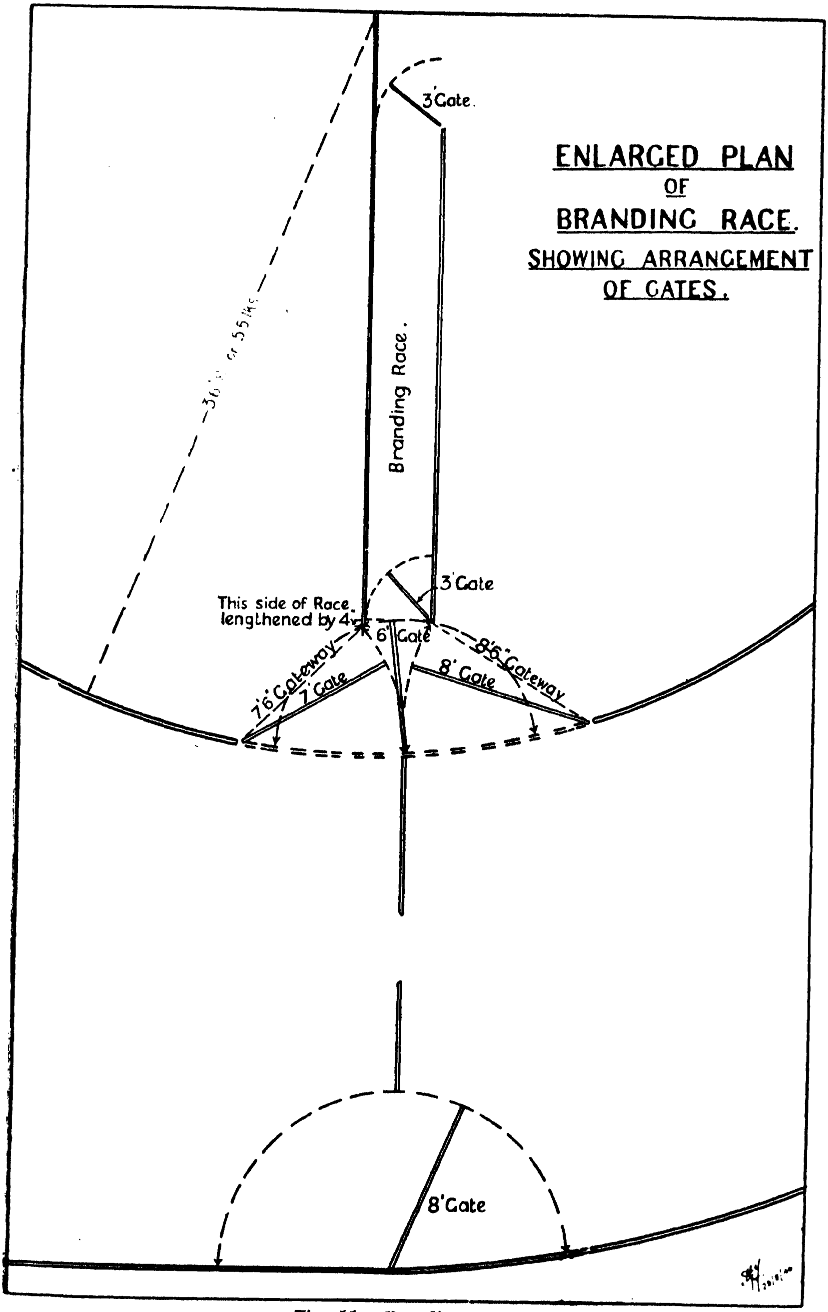


Fig. 11.—Branding race.

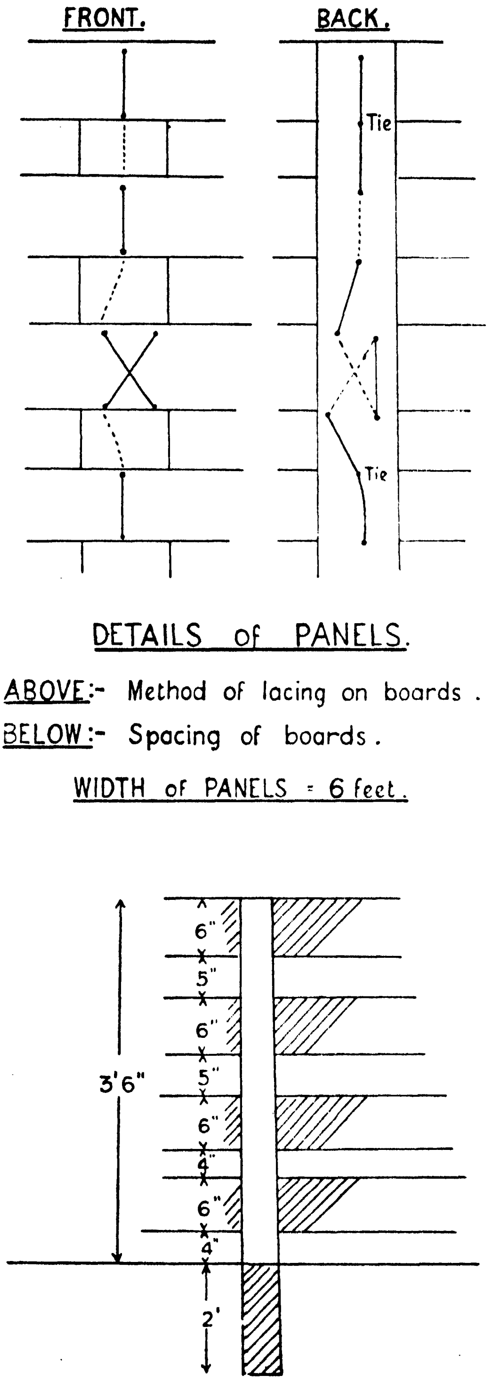


Fig. 12.—Details of sawn timber panels.

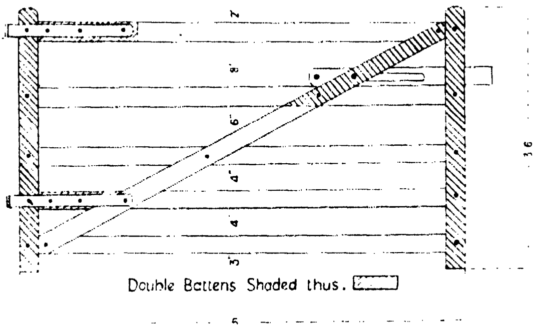


Fig. 13.
Six foot gate.

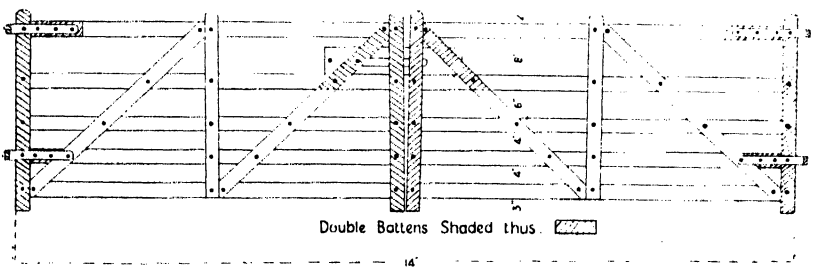


Fig. 13.
Pair seven foot gates (note gap between gates at top).

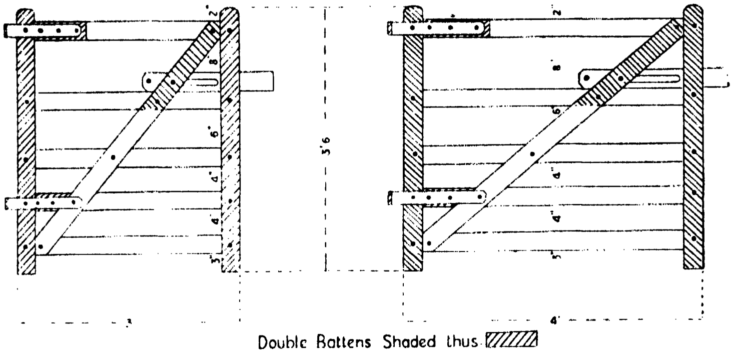


Fig. 13.
Three foot and four foot gates.

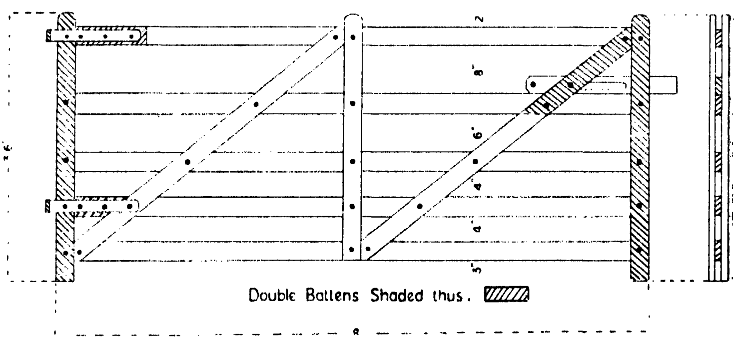


Fig. 13.
Fight foot gate.

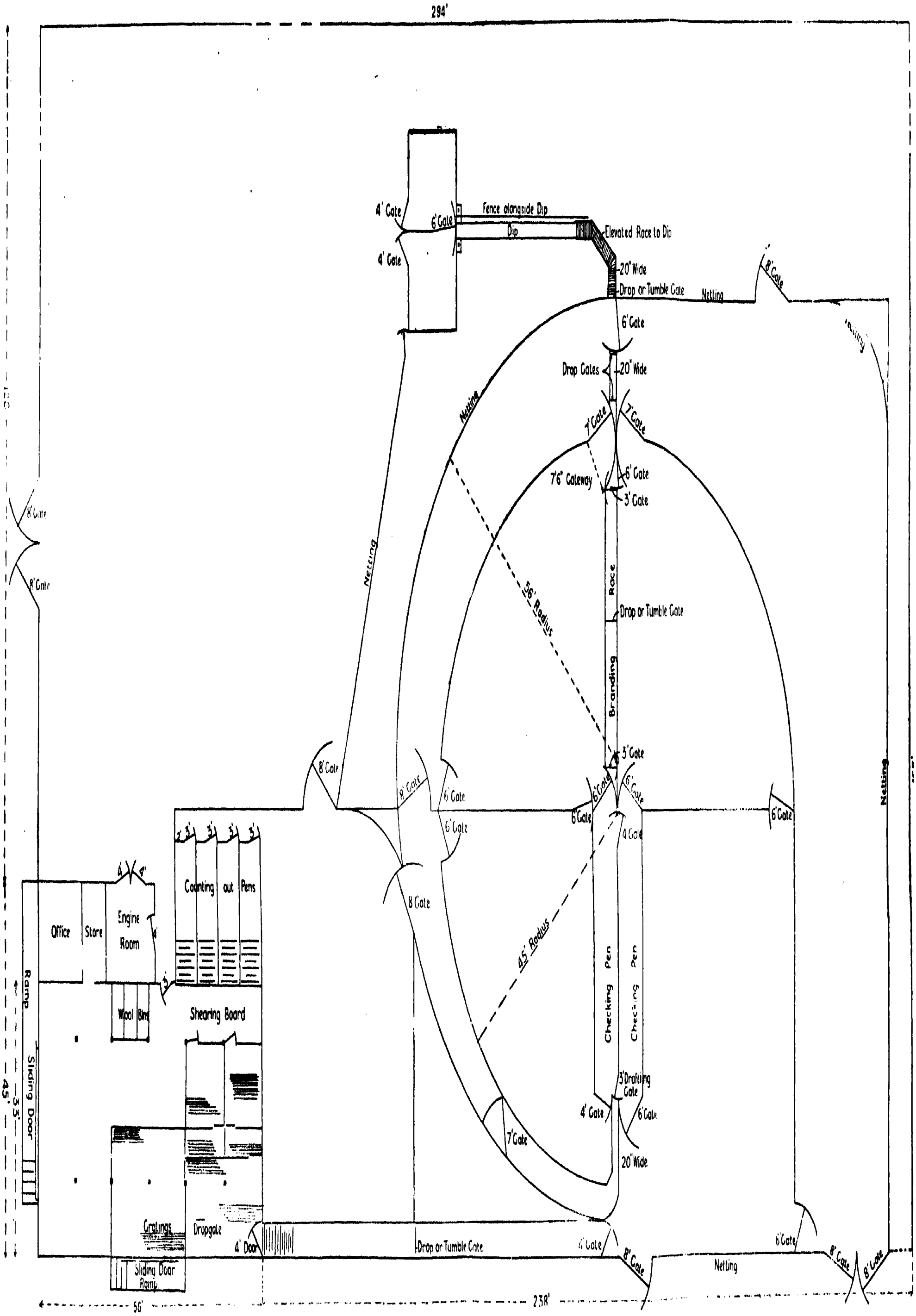


Fig. 14.—Layout of sheep yards, shearing shed and dip as at Wongan Hills Research Station.

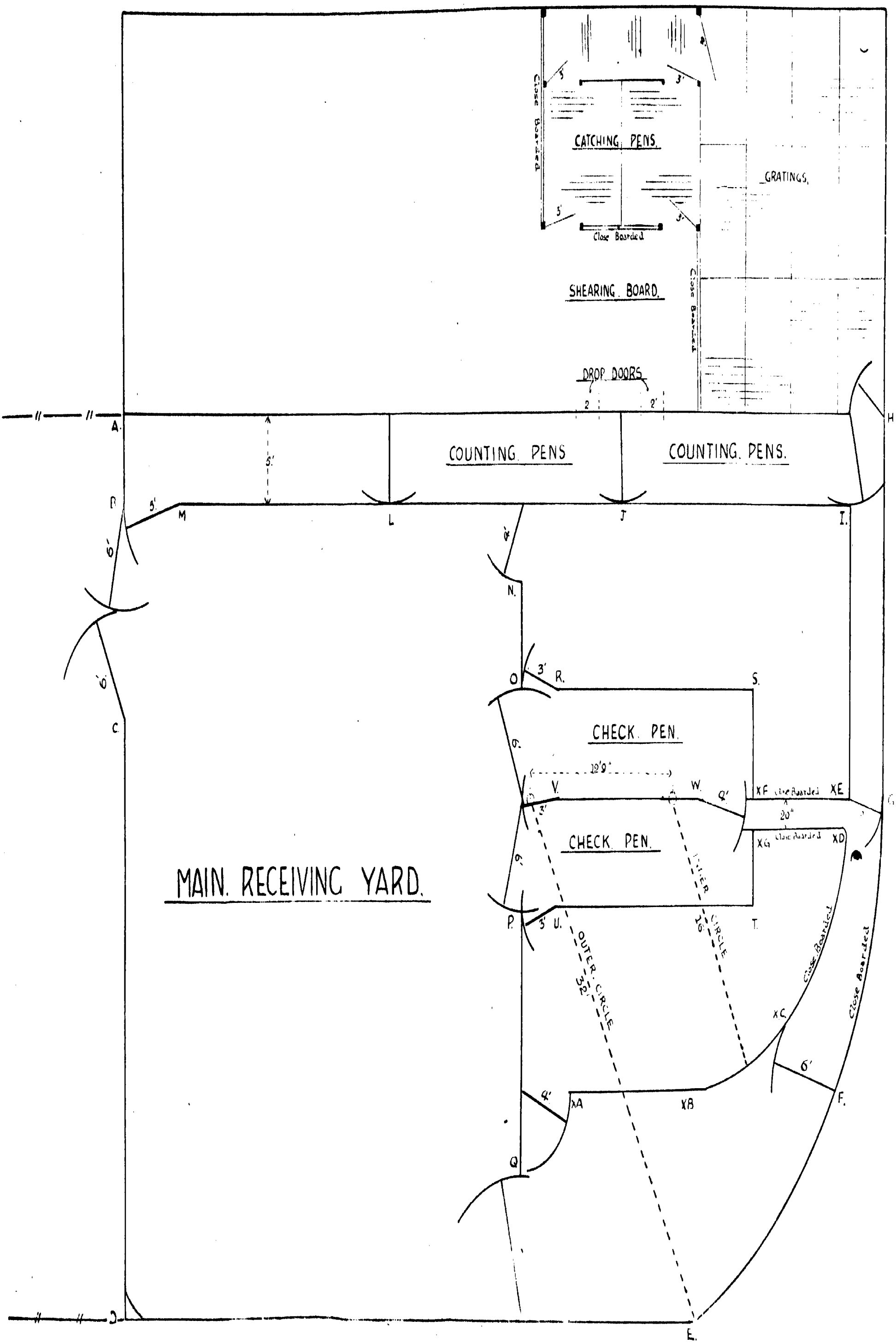


Fig. 15.—Layout of sheep yards and shearing shed as at Salmon Gums Research Station.

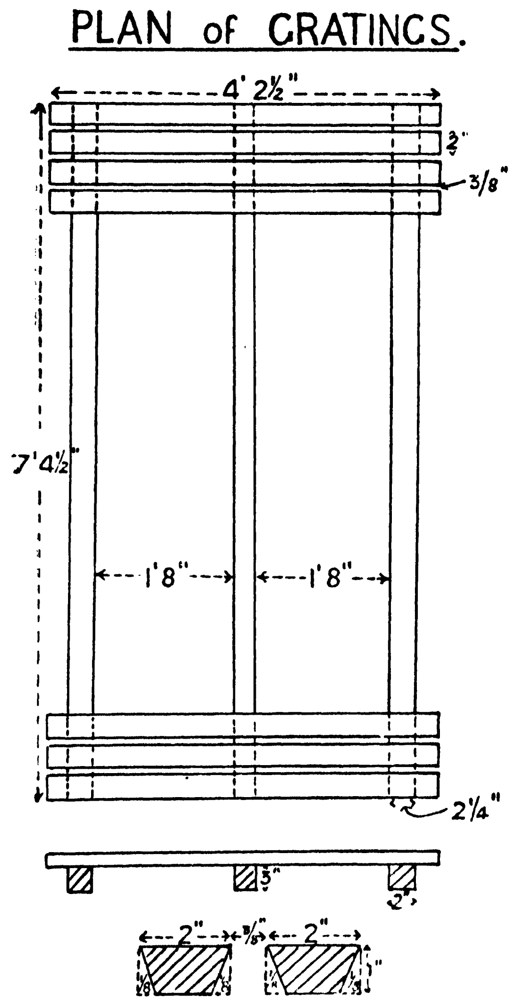


Fig. 16.—Plan of one section of gratings as used at Salmon Gums Research Station.

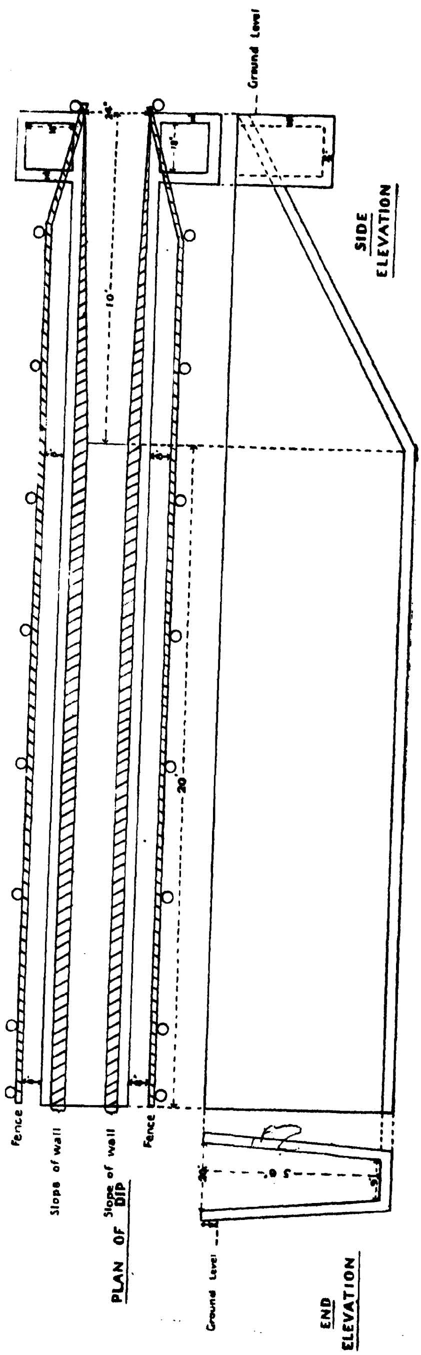


Fig. 17.—Plan of sheep dip.

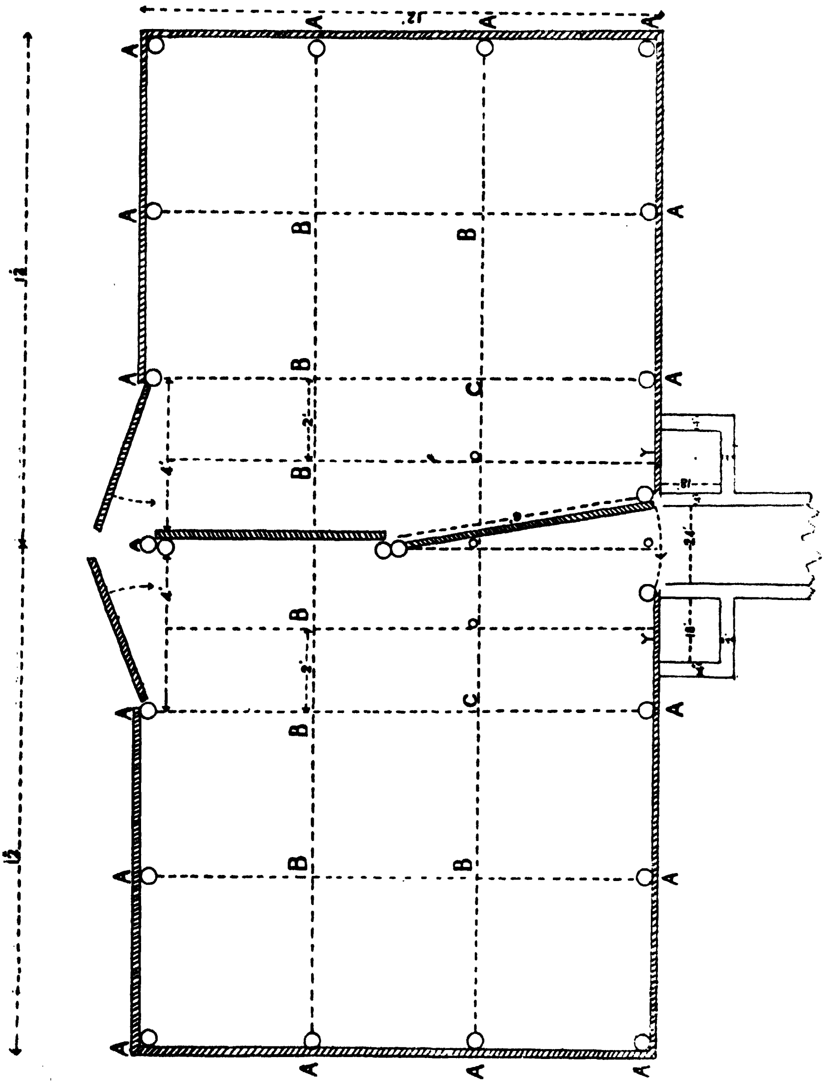


Fig. 18.—Plan of draining pens for sheep dip.

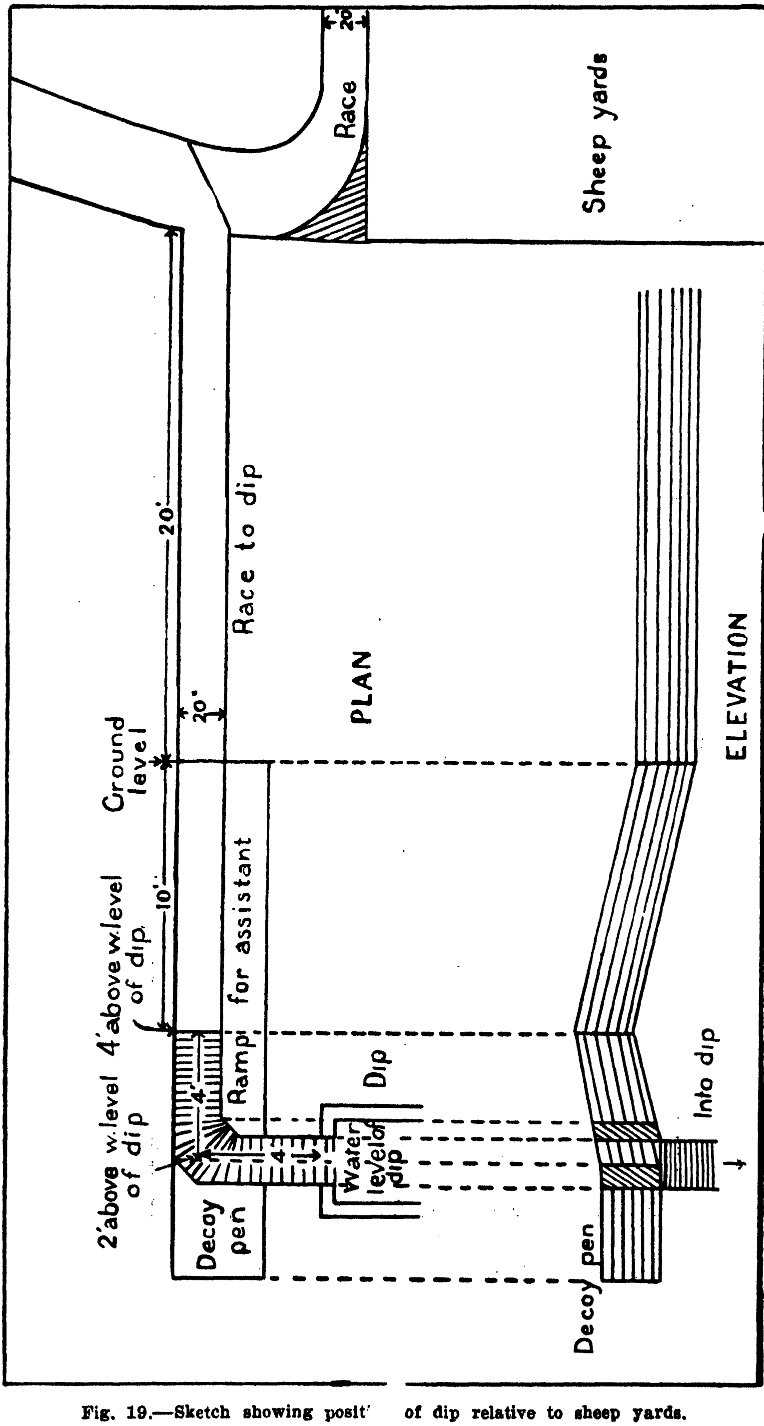


Fig. 19.—Sketch showing posit of dip relative to sheep yards.

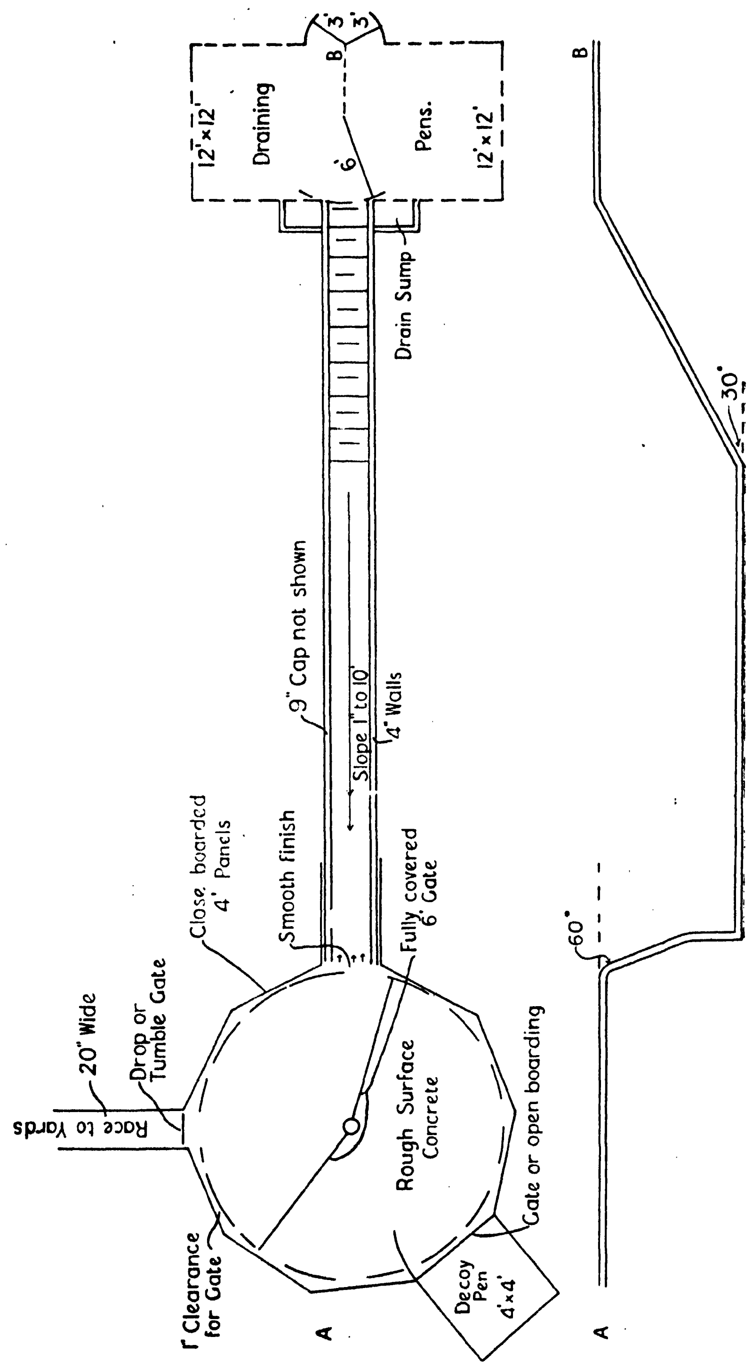


Fig. 20.—Sketch showing layout of dip with circular catching pen.

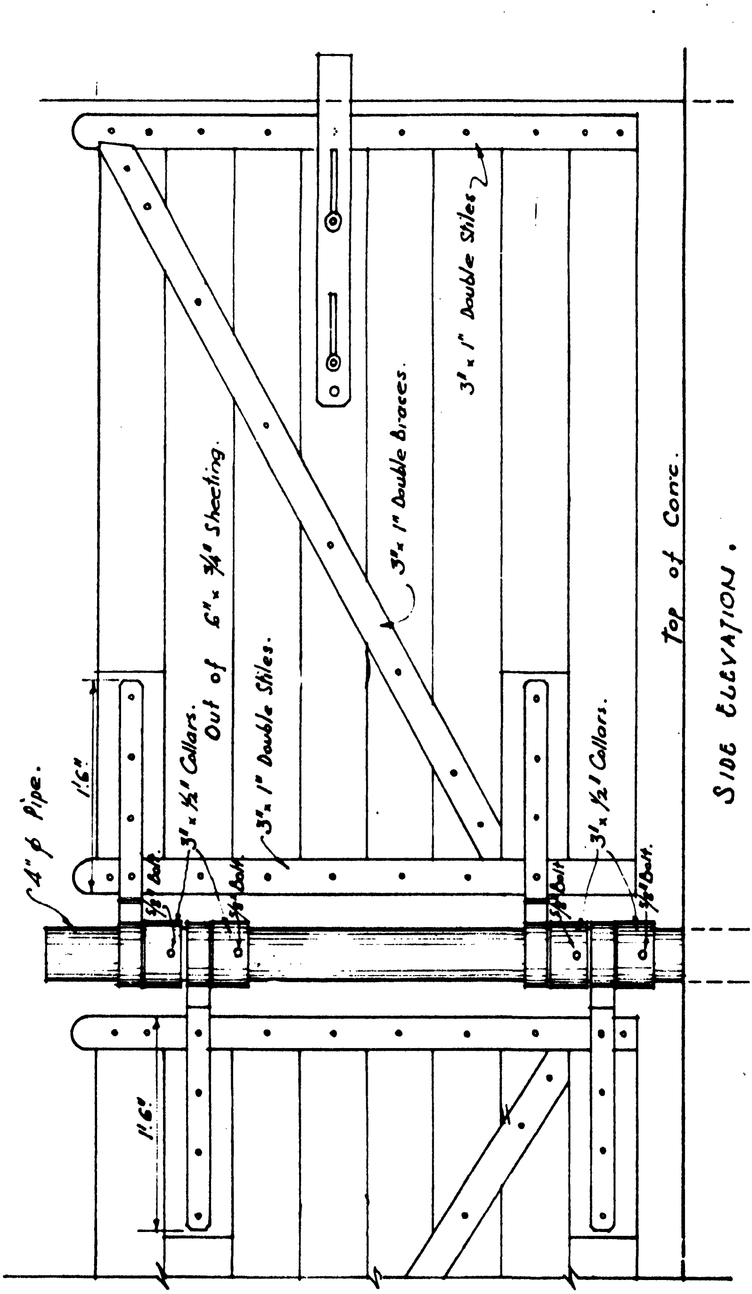


Fig. 21.—Sketch showing design and method of swinging gates in circular catching pen.

Auto Sexing in Poultry.

A. J. MILLINGTON.

PARTICULARLY in strains of fowls developed for high egg production, the value of the female chicks is many times that of the males. Consequently it is usually desirable to be able to separate the sexes as soon after hatching as possible.

In addition to the Japanese methods used by the professional chick sexers it is possible to obtain a high degree of efficiency by using certain inherited traits which express themselves very early in the chick's life. Seven traits

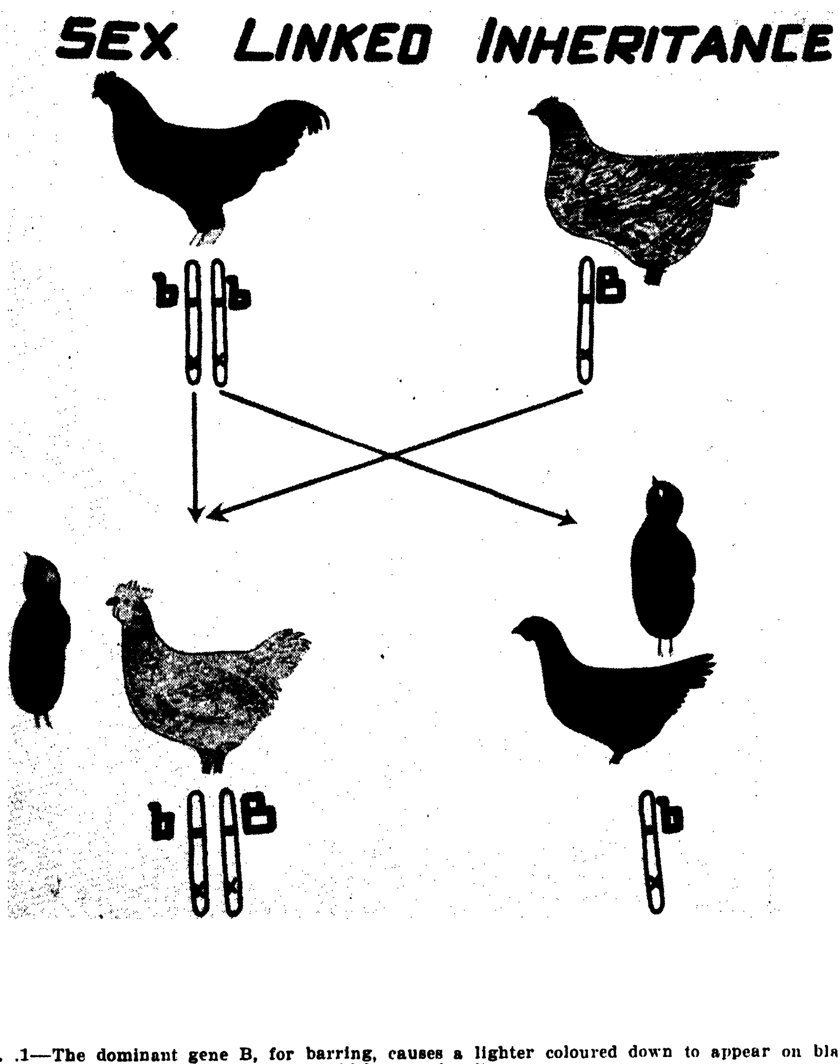


Fig. .1—The dominant gene B, for barring, causes a lighter coloured down to appear on black chicks carrying it.

are termed sex-linked because their inheritance is associated with sex and six of them can be used to differentiate the males and females at hatching. The trait which is used most extensively is the feather barring exhibited by such breeds as the Plymouth Rock.

Although from the viewpoint of inheritance, the genes are the fundamental unit, in practice they are not transmitted independently of one another. The genes are united in blocks by a thread similar to silk in composition and in inheritance those attached to the same thread or "chromosome" are inherited together.

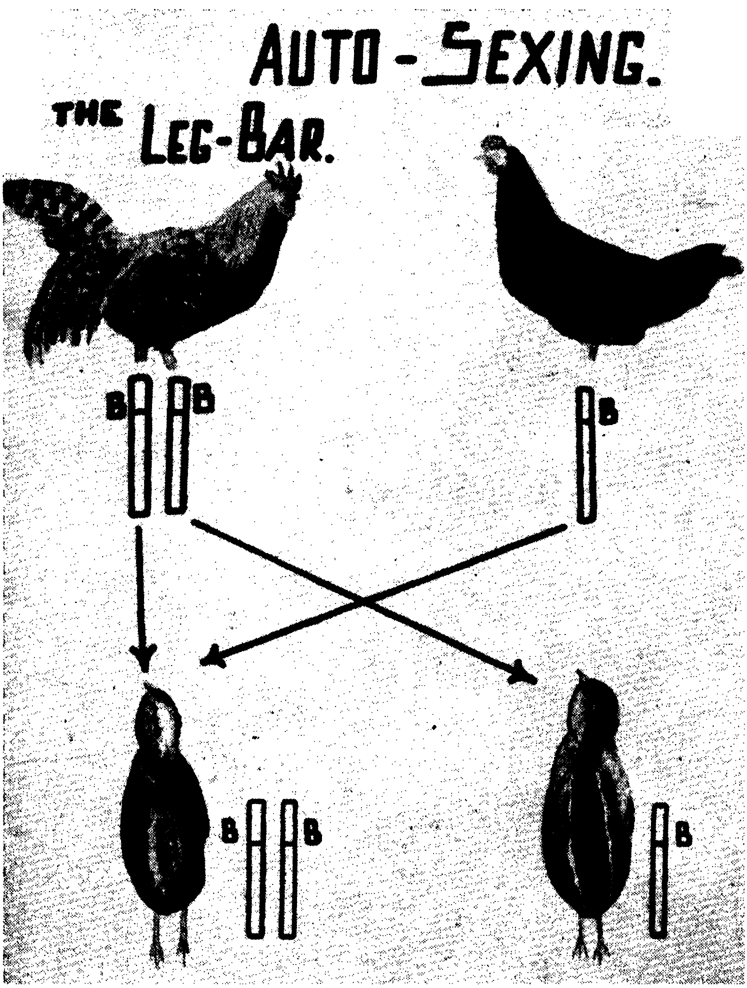


Fig. 2.—The dominant gene for barring, B, has an additive effect in lightening the down colour of chicks. The male chick having two genes for barring will be lighter in colour.

Sex is determined by genes located on the so called X-chromosome. In poultry the male possesses two X-chromosomes and the female one. The X-chromosome carries the genes such as Barring used in auto-sexing so that the males can have two, but the female only one gene for barring.

If a Rhode Island rooster and a Plymouth Rock hen are mated, one half of the chicks will have light spots on their heads and these will develop into males. The uniformly dark chicks are the pullets. This mating is shown schematically in fig. I. The reciprocal cross, Plymouth Rock male by a Rhode Island hen gives only chicks with light spots on their heads and sex differentiations cannot be made.

The auto-sexing in this instance applies only to the first generation of the cross between these breeds and, therefore, has very limited commercial application.

Consequently the development by Punnett and Pease of such breeds as the Legbar are of great interest to poultry breeders. This breed is derived, as the name implies, from a cross between a Canadian Barred Plymouth and a Danish strain of Brown Leghorns. The gene for Barring has an additive effect in lightening the typical down colour of the Brown Leghorn chick. As the male will have two and the female one gene Barring the former will be much lighter in colour than the latter at hatching. This is shown diagrammatically in fig. II.

There is considerable variation in the down colour of the chicks of the Legbar breed and selection should be made at hatching to retain the darker types which give a much better differentiation of the sexes.

Progeny Testing of Poultry.

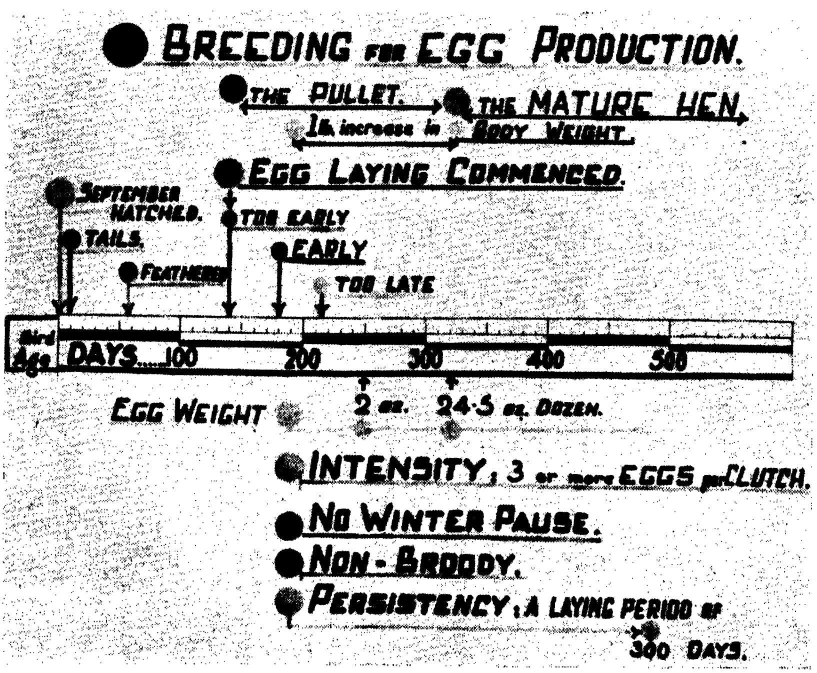
A. J. MILLINGTON, Geneticist.
E. LOVEGROVE, Poultry Adviser.

THE great fecundity and early maturity of the domestic fowl enable the breeder who is able to apply modern methods to make very rapid progress in raising the average level of egg production. American flocks have been developed in which a production of 240 eggs per bird each year is achieved with absolutely no culling, and this result was made possible by the adoption of progeny testing. Although the productivity of a hen is easily measured and expressed in terms of her egg production, the merit of the male can be assessed only indirectly. Thus by comparing the productivity of his daughters with that of their mothers, it is possible to measure the capacity of a male to transmit the heredity necessary for high production. American data indicates that slightly less than 10 per cent. of roosters used for breeding purposes are capable of raising the level of production. Genetic considerations imply that such birds must carry most of the heredity for high egg laying in a fairly pure condition and by using only proven males, the level of production can be materially and permanently raised.

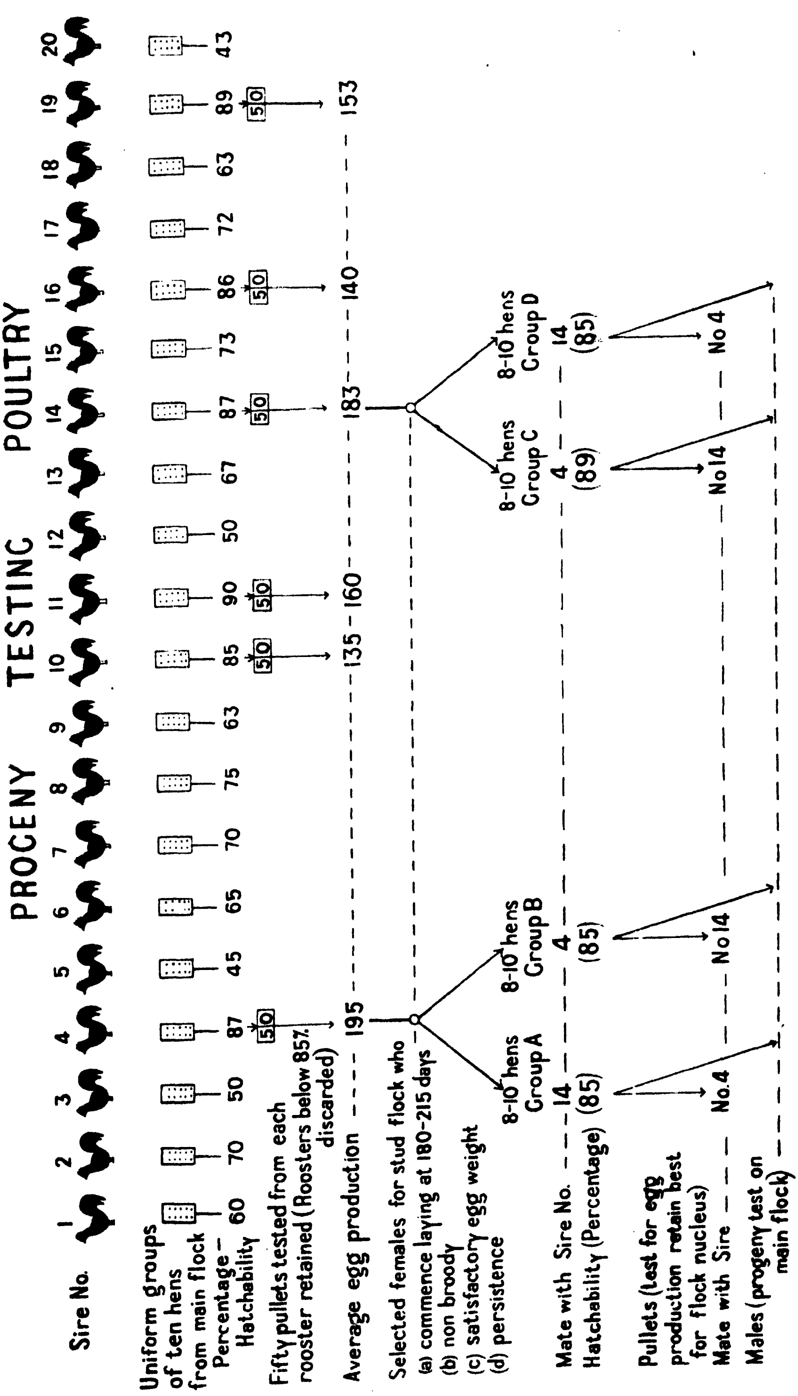
For each progeny-tested sire which the breeder requires, about 10-12 cockerels should be tested. If more birds can be tested, the progress is likely to be very rapid. Superior progeny-tested males should be used as long as they live.

Only young roosters should be progeny-tested since the trial occupies about eighteen months and proven birds will be at least 2½ years old. Each male to be tested, should be mated with a group of 8-10 average hens and it is important that the groups are about equal in respect to egg laying capacity, so that high producers are not mated to one sire and low to another. Males with low hatchability will be discarded. About 50 pullets should be raised from each male tested for egg laying, and it is essential that no culling within groups should be practised, but deaths, deformities and hatchability should be recorded. The housing and feeding of the various pens should be as alike as possible. For September hatched pullets, laying should commence when they are 180-210 days old. Birds commencing before or after this period should be banded for subsequent discard, as should all pullets showing broodiness. Persistency is the most important single characteristic and hens which lay for over 300 days without moulting should be excellent foundation birds, for mating with progeny-tested sires. They should be trapnested to give information on egg size etc. The above data will be considered for each rooster together with the average egg production of ALL his daughters.

The best manner in which to use the rooster, once his merit has been proven, will vary with circumstances. The effects of intense inbreeding on hatchability, etc, should be ascertained, but in general, proven roosters are best used in pairs. Each is mated with the selected daughters of the other and then with his grand-daughters so produced. However, it is not possible to forecast what the effects of inbreeding will be so limited matings of each proven male with his own daughters should be tried.



The high-producing hen has the characteristics: early maturity, high egg intensity, no winter pause, non-broody and delaying period of three hundred or more days without a moult.


PROGENY TESTING POULTRY
Sire No.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Uniform groups of ten hens from main flock
Percentage—Hatchability
60 70 50 87 45 65 70 75 63 85 90 50 67 87 73 86 72 63 89 43
Fifty pullets tested from each rooster retained (Roosters below 85% discarded)
50 50 50 50 50 50
Average egg production
195 135 160 183 140 153
Selected females for stud flock who
(a) commence laying at 180-215 days
(b) non broody
(c) satisfactory egg weight
(d) persistence
8-10 hens Group A
8-10 hens Group B
8-10 hens Group C
8-10 hens Group D
Mate with Sire No. 14 4 4 14
Hatchability (Percentage) (85) (85) (89) (85)
Pullets (test for egg production retain best for flock nucleus)
Mate with Sire No.4 No14 No14 No4
Males (progeny test on main flock)

Progeny testing is capable of lifting production rapidly to a fairly high level, probably to the vicinity of 200 eggs per bird each year. Thereafter, it is desirable to supplement it with data on the five characteristics which control fecundity in the domestic fowl, since it is possible that all five are not present in the strain. In this respect the poultry breeder is extremely fortunate inasmuch as in no other domestic animal is the inheritance of commercial production so well understood.

Fig. I sets out schematically the characteristics of the high producing hen. Many of them can be ascertained only with the aid of trapnesting. When selecting hens for the stud flock, trapnesting for a few days will yield important data on egg size and if this is not satisfactory, the birds can be banded for discard.

The programme set out schematically in Fig. II envizages the maintenance firstly of a stud or nucleus flock of females derived from and mated only with birds which have given a satisfactory progeny test and secondly a main flock to supply females for progeny testing males from the stud group.

The stud flock will comprise four or so families and in general best results will probably follow the use of progeny-tested males from one group on selected females of the other.

The surplus stock from the stud group will pass into the main flock and gradually improve it.

Details of suitable record forms and further details may be obtained from "Poultry Breeding Applied" by Hayes and Klein or from the Department of Agriculture, Perth.

The authors would like to thank Mr. A. M. Stewart of the Institute of Agriculture and Mr. R. Harrison for their helpful discussions.

SUMMARY: The important points to note in progeny testing poultry are:—

(1) The groups of females used for matings to progeny test roosters should be as uniform as possible and of average merit.

(2) As many males as possible should be tested and heavy culling for hatchability will reduce the number to be carried through for egg production tests. Hatchability should be 85 per cent. or better.

(3) In progeny testing the performance of ALL the daughters must be included.

(4) The two best sires should be retained for mating with the best daughters of the other to provide males for further progeny testing. The effects of inbreeding, i.e. Father-daughter or brother-sister matings should be ascertained.

(5) The best daughters of the best roosters will be used only in matings with males which have given satisfactory results in progeny tests. Progeny-tested males should be used for as long as they live.

Flax Seed Treatment.

W. P. CASS SMITH, Plant Pathologist.
H. L. HARVEY, Assistant Plant Pathologist.

INTRODUCTION.

THE treatment of agricultural seeds with fungicides is widely practised as a means of controlling losses due to disease-causing organisms carried by the seed or in the soil. Flax seed (or linseed) is no exception and seed treatments are now recommended and used in a number of countries where trouble of this nature is anticipated.

In Western Australia flax growing on a commercial scale was first attempted in 1940 and seed for that year's crop had to be imported from England. By arrangement with the Commonwealth Flax Production Committee who assumed control of the flax growing in Australia during the war years, the seed was dusted with ceresan UT 1875 A, before distribution to growers as a precaution against seed-borne diseases, and possibly damping-off losses also.

Yearly since that time practically all flax seed sown in Western Australia has been ceresan treated, and dusted seed has also been sown in certain years in the other flax growing States of the Commonwealth.

Subsequently, the Flax Production Committee considered that, as the incidence of seed-borne diseases appeared to be low, and seed "pickling" involved both extra expense and certain practical difficulties also, the practice was of very doubtful value.

Pathologists in all flax growing States were therefore requested to express their views on the matter. This department, while sympathising with the Flax Production Committee's desire to avoid unnecessary expenditure, advocated the continuance of seed "pickling" at least until its value had been disproved by experiment. Although the incidence of such seed-borne diseases as seedling blight (*Colletotrichum lini*) had proved to be low, it was considered that this might be due in part to the applied seed treatment. It was also thought that the sowing of untreated seed might result in losses from damping-off, a disease which has been reported from many different localities in Western Australia. Damping-off is caused by soil inhabiting fungi, which attack the germinating seeds, and destroy the young seedlings either before or just after they emerge above ground, leaving the grower in many cases with the firm conviction that he has been sold a poorly germinating line of seed.

At the request of the Flax Production Committee, therefore, the following experiments were carried out "in order to discover whether seed 'pickling' was of any definite benefit."

EXPERIMENTS.

Materials.

The seed used in these experiments was drawn from a commercial line of Concurrent imported from Victoria. This is the main variety grown in Western Australia. Most of the seed for the current season's crop had already been "pickled" with ceresan UT 1875 A at the rate of 2 ozs. per bushel, and this was one of the few "unpickled" lines available at that time. It was finally selected on the recommendation of the Flax Liaison Officer (Mr. H. G. Elliott) as being a

good average sample. The balance of this line was supplied to commercial growers for planting during the same season. Subsequent microscopic examination showed that there was little or no cracked or broken seed, while a seed test by the Ulster method (1) yielded no trace of *Colletotrichum lini* and only one colony of *Polyspora lini* per hundred seeds. In laboratory tests the sample showed 84 per cent. germination on blotting-paper pads.

The fungicides used and the rates of application are set out in Table 1.

TABLE 1.

SEED TREATMENTS.

Treatment No.	Fungicide.	Rate.
1	Ceresan U. 564 (8 per cent. Solution)	1 gallon per cwt.
2	Nomersan RD. 7846	†2 ozs. per bushel.
3	Agrosan	2 ozs. per bushel.
4	Control (Untreated)	
5	Ceresan UT. 1875 A.	2 ozs. per bushel.
6	Tetroc (Spergon)*	2 ozs. per bushel.

* Tetrachloro-para-benzoquinone.
† Maker's recommendation is 8 ozs. per bushel.

The dusts were applied at the uniform rate of 2 oz. per bushel, as this dosage was considered sufficient to compare their effectiveness as protectants against damping-off, and it was similar to that applied during the current season to commercial flax seed before distribution to growers.

Laboratory tests showed that germination of the seed was unaffected by any of the treatments.

Method.

It was originally planned to use both small hand-sown plots and large scale drill-sown plots, the latter having drill strips as plot units and both having a randomised block design with eight replications. The drill sown experiments, however, were abandoned because of the number of variable factors which would detract from the precision of the work. These factors include:—

1. Rate of flow through the drill of the seeds subjected to different treatments which in preliminary trials varied up to $12\frac{1}{2}$ per cent.

2. Variation in rate of flow between the different drill tubes.

3. Intermittent blockages of drill tubes.

4. Extreme variation of depth of sowing which would be accentuated by the extremely wet condition of the soil.

These and other factors contributed to the failure of the drill-sown experiments in the previous year.

The hand-sown experiments were arranged as randomised blocks each having eight replications of six treatments. Each treatment row measured five links and contained 330 seeds, calculated to be equivalent to 72 lb. per acre, and rows were spaced one link apart. Super. was first applied to the rows at the rate of one

(1) Muskett and Malone, 1941. The Ulster Method for the Examination of Flax Seed for the Presence of Seed-borne Parasites. Ann. App. Biol., 28; pp. 8-13.

and a half cwt. per acre. Rates of sowing and fertiliser and the row spacing were made to simulate field conditions. Sowing was at a uniform depth of half an inch.

Uniform plantings of the experiment were made between the 12th and 16th of June, 1945, at five different sites in the flax growing areas, viz., Wokalup State Farm, Donnybrook, Boyup Brook, Bridgetown and Muradup and a sixth planting was made at the Institute of Agriculture, University of W.A., Perth. With the exception of the University site, all sites were selected at random in well separated centres in the flax belt and were located in paddocks where commercial flax crops were being grown that year. The rainfall throughout the South-West of Western Australia during the growing period was heavier than it had been for many years with the result that surface wash damaged the plantings wholly or in part at all sites except Bridgetown. Second plantings were necessitated at Wokalup and Donnybrook and these were made on the 17th and 18th of July. At Muradup the experiment was abandoned, as further land for a second planting was not available.

The soil types at the experiment sites are as follows:—

Wokalup—brown to chocolate medium-heavy loam.
Donnybrook—red to chocolate medium loam.
Boyup Brook—grey gritty sandy loam.
Bridgetown—medium chocolate loam.
Muradup—gritty, gravelly loam.
University of W.A.—grey coastal sand.

Results.

(a) *Counts at Early Seedling Stage.*—Emergence counts were commenced on the 18th July, five weeks after planting and although the Donnybrook experiment had been partially destroyed by rain wash, three of the eight blocks were undamaged and were therefore included. The counts were taken in the middle 3½ links only (231 seeds) thus leaving a sown buffer at either end of each plot.

The counts on the late planted plots at Donnybrook and Wokalup were also made five weeks after planting, viz., 13th August, and again at Donnybrook two blocks were so badly damaged by heavy rain and surface wash that they were excluded. The mean emergence counts stated as percentages are presented in Table 2. Plants averaged from one inch to 1½ inches in height when the counts were taken.

TABLE 2.

COUNTS AT SEEDLING STAGE—MEAN PERCENTAGE EMERGENCE.

Treatment.	Donnybrook (1st Planting). 3 blocks.	Donnybrook (2nd Planting). 6 blocks.	Bridgetown. 8 blocks.	Boyup Brook. 7 blocks.	University. 7 blocks.	Wokalup. 8 blocks.
1	49·6	51·6	56·9	54·2	48·4	52·7
2	33·5	54·0	57·6	55·4	53·1	53·1
3	24·4	48·2	48·2	40·9	36·1	42·0
4	17·0	40·8	45·2	29·6	35·2	36·6
5	53·1	60·9	68·4	62·6	58·5	61·1
6	46·9	65·9	64·0	55·5	56·0	61·7
Difference for significance at 1 per cent. level	25·61	12·68	7·84	9·28	14·44	9·65

It will be seen from Table 2 that seed treatment with ceresan and tetroc significantly increased the emergence at all six sites, ceresan wet and nomersan at five sites and agrosan at only one site.

To give a picture of the results from all sites as a whole at the early seedling stage the mean results from the 39 blocks are presented in Table 3.

TABLE 3.

MEAN PERCENTAGE EMERGENCE FROM ALL SITES (39 BLOCKS).

Treatment.	Percentage Emergence.
1. Ceresan U. 564 (wet)	52·6
2. Nomersan	53·1
3. Agrosan	41·8
4. Control (Untreated)	36·0
5. Ceresan UT. 1875 A.	61·8
6. Tetroc	59·5
Difference for significance at 1 per cent. level	4·55

The improvement in emergence due to the use of ceresan and tetroc is highly significant when compared with untreated seed. The remaining treatments while producing significant increases were not as effective as ceresan and tetroc.

(b) *Counts at Flowering Stage.*—To ascertain whether the differences in plant numbers at the emergence stage due to seed treatment were still reflected later, plant stand counts were also made at the flowering stage, commencing on the 8th of October. The experiments at the University and at Donnybrook (first planting) were not included in these counts, because the former was located in a non-commercial area, and growth after emergence, was unthrifty, and the latter was upset by further rain wash. The results are shown in Table 4.

TABLE 4.

COUNTS AT FLOWERING STAGE—MEAN PERCENTAGE PLANT STAND.

Treatment.	Wokalup. 8 blocks.	Donnybrook. 6 blocks.	Boyup Brook. 7 blocks.	Bridgetown. 8 blocks.
1	52·6	41·3	18·9	53·1
2	51·2	46·4	25·7	51·5
3	42·5	42·0	19·3	41·8
4	35·1	34·6	14·7	42·3
5	63·3	52·0	26·2	59·6
6	61·8	56·0	23·8	54·7
Difference for significance at 1 per cent. level	1·04	14·85	No difference in treatments	10·16

Compared with plant numbers at the emergence stage, a general reduction in plant stand was noticed which was apparently due to heavy weed growth. At Boyup Brook weed competition was so great that the stand was very sparse, and differences were not significant. However, significant differences occurred at all

the remaining sites. Observations made during growth and at the flowering stage revealed that the only disease present of any consequence was rust (*Melampsora lini*) which developed more or less uniformly throughout the plots.

As was done with the emergence counts, counts taken at the flowering stage were grouped to give a picture of the average plant stand from all sites.

Table 5 presents the mean percentage plant stand from all 29 blocks in four different localities.

TABLE 5.

MEAN PERCENTAGE PLANT STAND FROM ALL SITES AT FLOWERING STAGE (29 BLOCKS).

Treatment.	Percentage Plant Stand.
1. Ceresan U. 564 (wet)	41·8
2. Nomersan	44·1
3. Agrosan	36·6
4. Control (Untreated)	32·0
5. Ceresan UT. 1875 A.	51·0
6. Tetroc	49·5
Difference for significance at 1 per cent. level	5·63

It will be noted that significant differences in plant numbers at the emergence stage due to seed treatment are still maintained at flowering time, with the exception of the agrosan treatment.

The differences in mean plant stand closely follow the same trend as the mean emergence differences while the stands resulting from the use of ceresan UT 1875 A and tetroc are better than the remainder.

The Organisms Associated with the Losses from Damping-off.

An examination of the plots at an early stage of growth indicated that a majority of affected seedlings had been destroyed by damping-off before emergence through the soil.

A number of rotted seeds and young seedlings were obtained from the control rows, and isolations from these yielded fairly consistently *Pythium* spp. and *Phytophthora* sp. Soil isolations from the same places yielded predominantly *Pythium* sp. and *Fusarium* sp.

Species of both Pythium (2) and Phytophthora have previously been recorded in other countries as causing a damping-off of flax and both are commonly occurring soil inhabitants.

DISCUSSION.

Under the conditions of these experiments, the treatment of flax seed with fungicides reduced losses from damping-off, thereby producing better stands.

Uniform experiments in several well separated localities showed that increased plant numbers were obtained at the emergence stage from all five seed treatments, and at the flowering stage from all treatments except agrosan.

Sowings of 100 seeds of variety Concurrent per foot of row (84 of which were germinable) yielded an average of 36 seedlings at the emergence stage, from untreated seed, compared with 62 and 60 from seeds treated respectively at 2 ozs. per bushel with ceresan UT 1875 A and tetroc (spergon), the two most effective fungicides. (See Table 3.)

(2) Millikan, C. R., 1945. "Damping-off" Disease of Flax. *Jour. Dept. Agric., Vic.* 43, 177-181.

At the flowering stage, an average stand of 32 plants per foot of row had survived from the untreated seed, compared with 51 and 50 from the ceresan and tetroc treated seed, which maintained their superiority over other treatments. (See Table 5.)

It is thus obvious that under conditions when damping-off occurs a more effective utilisation of the seed, and uniformly better stands can be ensured by "pickling." These benefits may in the final analysis more than offset the cost of "pickling."

The occurrence of damping-off is influenced by seed quality, soil and climatic factors. Poor seed samples, containing much cracked or broken seed, are particularly liable to attack, but samples, apparently of good average quality may also be affected, as happened in these experiments.

The occurrence of seasonal and soil conditions conducive to damping-off cannot be accurately forecasted. However, the disease may develop under widely varying conditions, for in these experiments when it developed at all sites, very wet conditions were experienced, whereas in Victoria damping-off was also reported under dry conditions (2).

It is also of interest to note that ceresan UT 1875 A which proved to be one of the two most effective dusts in these experiments, has been generally used in Western Australia for pickling flax seed supplied to commercial growers, and that it is less costly than tetroc (spergon) which is equally effective.

ACKNOWLEDGMENTS.

The authors are indebted to the Flax Production Committee for financial assistance which enabled these experiments to be carried out. They also gratefully acknowledge assistance received from the Conservator of Forests, Mr. T. N. Stoate, in connection with the statistical analysis of the results, and the helpful co-operation of a number of departmental officers, and the following growers, on whose properties the experiments were planted:—Messrs. J. Mitchell, Donnybrook; Brooks and Dent, Boyup Brook; F. Hill and H. Haggerty, Muradup; and M. Scott, Bridgetown.

Acetonaemia (Acidosis, Ketosis) in the Dairy Cow.

C. R. TOOP, Senior Veterinary Surgeon.

ALTHOUGH the disease acetonaemia occurs quite frequently in dairy cows it is rarely recognised as such by the dairy farmer. A considerable number of cases of the disease have been encountered in the field and many others have been reported in which the description furnished has left little doubt concerning the identity of the condition. The available information suggests that the incidence of the disease has increased during recent years. For the most part acetonaemia occurs during the first six weeks of lactation and is characterised by loss of appetite, marked reduction of milk yield, rapid loss

of condition, listlessness and constipation and at times by the presence of a peculiar sweetish odour which may be detected in the breath, milk and urine. In some cases there are nervous complications.

The mortality rate is low and recovery is the rule. Since the disease occurs during early lactation when it greatly depresses the milk flow it may become a source of considerable loss. The majority of cases respond promptly to appropriate treatment.

CAUSE.

The actual cause of the disease has not been determined but there is little doubt that it is a nutritional disorder. It is believed to be due to a derangement of metabolism in association with which the blood sugar falls below the normal level and abnormal amounts of toxic substances known as ketone bodies accumulate in the blood and tissue fluids. This may be due to a failure on the part of the animal to derive a sufficient amount of carbohydrate from its diet or to an inability to properly utilise the carbohydrate that is available. Carbohydrates are represented by such substances as starch, fibre and sugars and provide the principle source from which an animal derives its energy requirements. When the carbohydrate falls below the required level the animal is forced to draw upon its fat reserves. When fat is completely burned or oxidised in the body the end products are carbon dioxide and water which are excreted and cause no ill effects. For the complete combustion of fat an adequate supply of carbohydrate is necessary. When the supply of carbohydrate is inadequate the oxidation of fat cannot proceed to completion but becomes arrested at an intermediate stage wherein the fat has become converted to substances known as ketone bodies which accumulate in the blood and are excreted in the breath, milk and urine to which they impart a characteristic odour. Ketone bodies are acid in reaction and possess toxic or poisonous properties. Acetone is one of these and it is from the presence of this substance in the blood that the name acetonaemia is derived.

It has recently been claimed by American workers that acetonaemia may result from deficiency of Vitamin A and spectacular recoveries have been reported from treatment with this substance. The original findings, however, do not appear to have been borne out by subsequent observations. In Western Australia the disease occurs at all periods of the year and is probably most prevalent when green feed is abundant. Since green feed is a rich source of Vitamin A it seems unlikely that a deficiency of this Vitamin would be an important factor in relation to the occurrence of the disease in this State.

SYMPTOMS.

Although the disease may occur at any time during the lactation period the majority of cases occur from about a week to six or eight weeks from the date of calving. Cows of any age may become affected. The condition is most frequently observed in well nourished high-producing animals. Two forms of the disease may be recognised (1) the digestive form and (2) the nervous form. The majority of cases are of the first mentioned type.

Digestive Form.

In the digestive form of the disease there is a sudden or gradual loss of appetite and this is accompanied by rapid loss of condition and a marked fall in the milk yield. The cow is dull and listless and a sweetish chloroform-like odour of acetone may in some cases be detected in the breath, milk and

urine. The detection of this characteristic odour may depend on the keenness of the sense of smell and while it will immediately be recognised by some observers upon entering the shed occupied by an affected cow nothing unusual will be noticed by others, The bowels are usually constipated, droppings being passed infrequently and in small amounts. Diarrhoea has been observed in some cases but this is unusual.

Nervous Form.

In addition to the symptoms occurring in the digestive form of the disease cows affected by acetonaemia may show a variety of nervous symptoms. In some cases there may be constant licking of the skin or licking or biting at the manger and other objects. There may be sucking of the tongue, slobbering from the mouth, grinding of the teeth, champing of the jaws and rolling of the eyes. The gait may be stagge ing and unsteady and the cow may have difficulty in remaining on her feet; she may fall and may remain down for some time before being able to regain her feet. Other symptoms which have been described include marked excitement with wild expression and staring eyes, violent movements, walking in circles, stringhalt and convulsions.

It should be recognised that the digestive form of the disease predominates and that a smaller proportion of cases may become complicated by one or more of the nervous symptoms above described.

COURSE OF THE DISEASE.

The majority of cases of acetonaemia terminate in recovery. With appropriate treatment recovery will usually occur within the space of a few days. Untreated cases or those which fail to respond to treatment, however, may persist for several weeks during which period the animal becomes emaciated and the already diminished milk flow may cease entirely. In prolonged cases the cow may be rendered worthless until the next lactation period. Severe emaciation and debility may result in the death of the animal. The mortality rate, however, is very low. Some animals are subject to recurrent attacks of the disease an apparent recovery accompanied by a return of appetite and rumination being followed shortly afterwards by a relapse.

DIAGNOSIS.

From a consideration of the history of the attack and the symptoms exhibited the diagnosis of the disease will usually present little difficulty. When symptoms of loss of appetite, rapid wasting, greatly diminished milk yield and constipation occur during early lactation, acetonaemia should be suspected. If in addition the characteristic odour of acetone is detected in the breath or should any of the nervous symptoms described make their appearance this will provide confirmatory evidence. It is, however, necessary to mention that an odour of acetone may occasionally be present in the breath of apparently healthy cows or in cows suffering from some other diseases and it is consequently unwise to place absolute reliance on this feature alone. In order to confirm the diagnosis samples of milk or urine from an affected animal may be submitted to a simple chemical test in which a positive result is denoted by a colour reaction. A strongly positive reaction considered in conjunction with the symptoms will serve to place the diagnosis beyond doubt. When confirmation is desired milk or urine samples may be forwarded to this Department for testing. The amount of each need not exceed a fluid ounce and the sample should be despatched immediately after collection, otherwise it may prove unsuitable.

TREATMENT.

The most rational method of treatment consists in the injection of a solution of the sugar glucose which results in a reduction of the toxic ketone bodies circulating in the blood accompanied by a corresponding improvement in the condition of the animal. The use of a 40 per cent, solution of glucose is recommended 500 cc. of which(approximately 7 ounces of glucose dissolved in 17 ounces of boiling water and allowed to cool) is injected into the jugular vein or subcutaneously (beneath the skin). A single injection may result in recovery but 4 or 5 injections repeated on successive days may be necessary before the desired result is obtained. When treatment of this kind becomes necessary it is desirable that the services of a veterinary surgeon should be obtained.

An alternative method of treatment which is very effective and may be applied by the dairy farmer consists in the administration of chloral hydrate, one ounce of which should be given night and morning for the first two days of treatment followed by half an ounce once daily for the next six days. In the administration of chloral hydrate the prescribed dose of the drug is dissolved in a pint of hot water and a pint of treacle or molasses added, the mixture being given to the cow in the form of a drench. Many cases of the disease will respond satisfactorily to this method of treatment. Since the actual cause of the disease has not been determined no really effective method of prevention can be advocated. Molasses given in the ration at the rate of 1 to 2 pints daily may be found beneficial and it has been shown to be capable of preventing the disease in cows which are subject to an annual attack. In addition it is a valuable adjunct to treatment.

Animal Breeding.

A. J. MILLINGTON

[In view of the wide interest being taken in Progeny Testing and other aspects of Animal Breeding, the following article, a talk given by Mr. Millington at Merredin on 22nd June, 1946, is reproduced with illustrations.—Editor.]

ALTHOUGH to the casual observer, wild animals appear very uniform, close examination reveals considerable variability, which becomes more marked following domestication and particularly inbreeding. Man, as an agriculturist, has endeavoured to turn this variability to his own purposes by retaining those which are most profitable in respect to milk, wool egg or meat yield. The basis of most animal breeding is the rule "like begets like," but the conception is correct only in the broadest sense. It is certainly too inexact for effecting notable improvement within most of the established breeds of livestock.

Most farm animals have the capacity to beget progeny very unlike themselves in respect to their looks or even their production or ancestry, making these

characteristics very uncertain guides as to their progeny. In every generation there is a proportion of relatively unproductive animals which must be culled if the level of production is to be maintained.

PERCENTAGE OF PROGENY WHICH MUST BE RETAINED AS REPLACEMENTS.....

Kind of Animal	Female	Male
Beef Cattle	40-50	3-5
Dairy ..	50-65	4-6
Sheep	45-55	2-4
Pigs	10-15	1-2
Fowls	10-15	½-2

Data by Lush.

The Ineffectiveness of Culling.

Experience and innumerable experiments have shown that culling is a slow and ineffective method of eliminating the heredity which causes the low producers to appear. This is because in culling on the basis of production and appearance, the effects of indifferent heredity are often masked by high level feeding. It is also made ineffective, firstly by the inability to directly test the male for such important characteristics as egg or milk production and, secondly because high producers can transmit heredity which will give low production in the progeny.

Apart from the economic loss incurred in raising unproductive animals which must be eliminated at maturity, the scope for raising production by culling is restricted since in the large farm animals about one half of the females bred must be kept if numbers are to be maintained. However, even in the large stock only one male in twenty is required for breeding purposes, and this provides ample scope for selection.

Any breeding programme, therefore, becomes one of retaining the best of the twenty males, and its success will be determined largely by the efficiency of the selection methods used in eliminating the nineteen less desirable ones.

Assessing Merit in Farm Animals.

The three bases of selection used to assess merit in breeding animals are firstly, appearance; secondly, pedigree (merit in relatives); and thirdly, productivity. All three are dependent on heredity in part at least, and are, therefore, related to one another. No one of them or even all three in combination, is a good measure of heredity and genetics suggests the "genes" as a basic means of estimating the value of breeding animals. Genetics may be for the geneticist, but it does provide a universal currency in which the merit of breeding animals can be expressed. It also has laws which can predict the likely effectiveness of any breeding programme in producing animals in high genetic merit.

The Gene.

The "genes" are the units in heredity and from the breeder's viewpoint they differ in value. Any character can be assessed in terms of genes, and once purity has been obtained at whatever level of desirability, the animal will, for practical purposes, continue to breed true to that characteristic. The genes cannot be converted from one to another but they can be exchanged one for the other by breeding practices and real improvements once achieved are permanent.

The Bridge between Generations.

The contribution of the parents to the heredity of the progeny in terms of material is small beyond comprehension. The 1,500 or so million human beings at present inhabiting the earth, derive their heredity from microscopic amounts of material which, added together, would equal two drops of water, one from the fathers and one from the mothers. Minute as the quantities are, they apparently have the capacity, through the genes, for producing almost infinite variation.

Each characteristic of an animal such as horns, coat colour, milk production, is directly controlled by a specific gene or genes.

The gene which has the task of developing a character, such as red coat colour in cattle, goes on for generations in hundreds of thousands of beasts producing the chemical causing this result. Then, for some unknown reason, it produces a different substance, and this change is immediately expressed by a different basic coat colour, for example, black. The change is called a "sport" or mutation, and once effected is permanent. Over the thousands of years of evolution, genes have "sported" several times, so that each character has its alternative types. In respect to coat colour, one gene produces a substance which results in black hair, an alternative red hair, and a third white hair. By judicious breeding, the owner can manipulate the genes and obtain thereby beasts with any one of the three alternative coat colours.

Genes and the "Pure Bred."

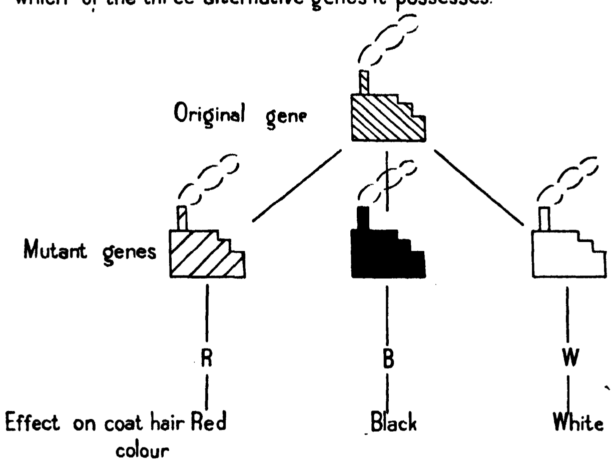
The "throwback" whereby an ancestral characteristic suddenly reappears is well known to animal breeders. It indicates a mechanism whereby heredity can be transmitted unchanged through generations without there being any visible evidence of its presence. This mechanism is necessary in nature to preserve the variability essential for evolution, and among domesticated animals, for strain selection.

GENE FUNCTION

Each gene functions by manufacturing a chemical substance which produces a certain effect on the animal possessing it

During evolution each gene has "sported" (mutated) several times. The mutant produces a chemical different from that of the original gene and the change is reflected in the animal possessing it.

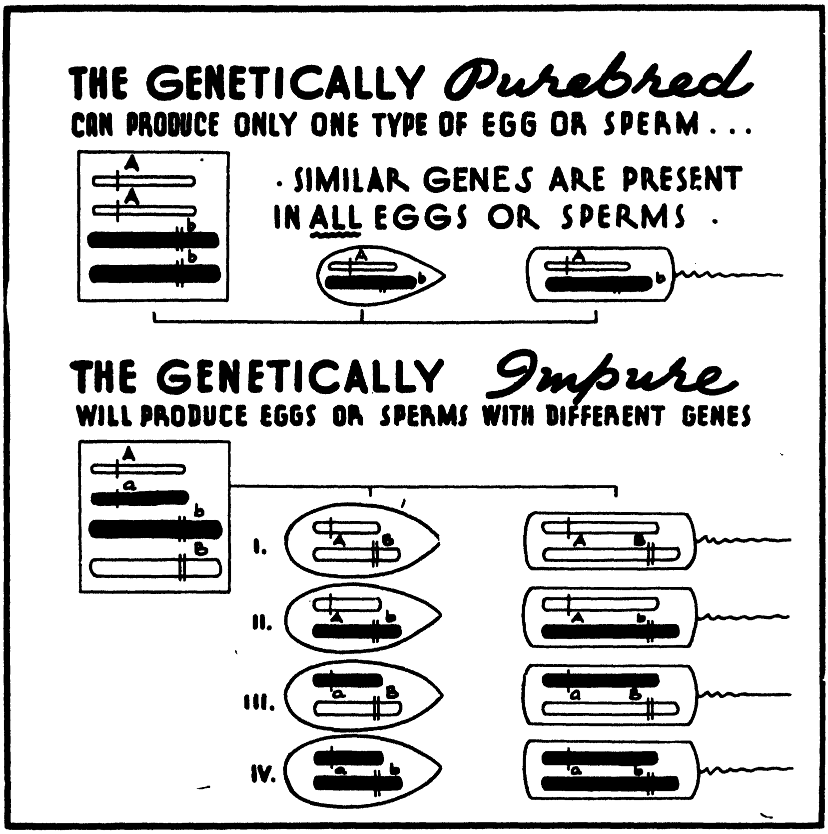
In cattle a beast may have a red, a black, or a white coat colour, depending on which of the three alternative genes it possesses.



Since the animal inherits a gene for coat colour from each parent, it can have either of the above in duplicate, or any two in combination. Some genes mask (dominate) others, so that when the pair is unlike, the beast may look like one parent or be intermediate between the two.

Gene combinations	Coat hair colour
R R	Red
B B	Black
W W	White
R B	Black (Substance B prevents R from expressing itself)
R W	Red roan – a mixture of red and white hairs.
B W	Blue roan – a mixture of black and white hairs

Animal breeding is difficult because most beasts are themselves the expression of a combination of the dual heredity which they received from their two parents. They usually possess considerable heredity which is not visible in themselves but which they can transmit to their progeny.



The sperms or eggs of genetically pure animals all contain identical genes capable of producing only one type of animal. Genetically impure animals produce eggs or sperm with dissimilar genes resulting in variable progeny.

The dual behaviour is due in part to the animal possessing every gene in duplicate. In the Aberdeen-Angus for instance, each beast will have two genes for each characteristic such as black coat colour. One of the genes of each pair is derived from the sire and the other from the dam via the sperm and egg respectively.

Although the animal has a duplicate set of genes, the eggs or sperm which it produces will receive only one member of each pair. This mechanism is necessary to keep the number of genes constant. During the formation of eggs or sperm, the members of each pair are separated and only one or the other goes into each reproductive body. At fertilisation the duplicate condition is restored.

In the Aberdeen-Angus, the sperm of all males will receive one or other of the genes for black coat colour which the animal possesses. In respect to this character all the sperms are alike inasmuch as they can transmit only one type of

heredity. Similarly all the eggs of the females will carry the gene for black coat colour and the offspring will possess two genes, both producing the substances necessary for that coat colour. This is the genetic concept of the "pure bred." Because they can transmit only one type of gene to their progeny they can produce only animals identical with themselves in respect to heredity. This fixity makes "appearance," "performance" and "pedigree" reliable bases for selecting breeding animals.

Likewise in a herd of Red Poll cattle all the sires and dams will transmit the gene for red coat colour and only animals of this type possessing two genes for the character will be produced.

The Cross and Gene Dominance.

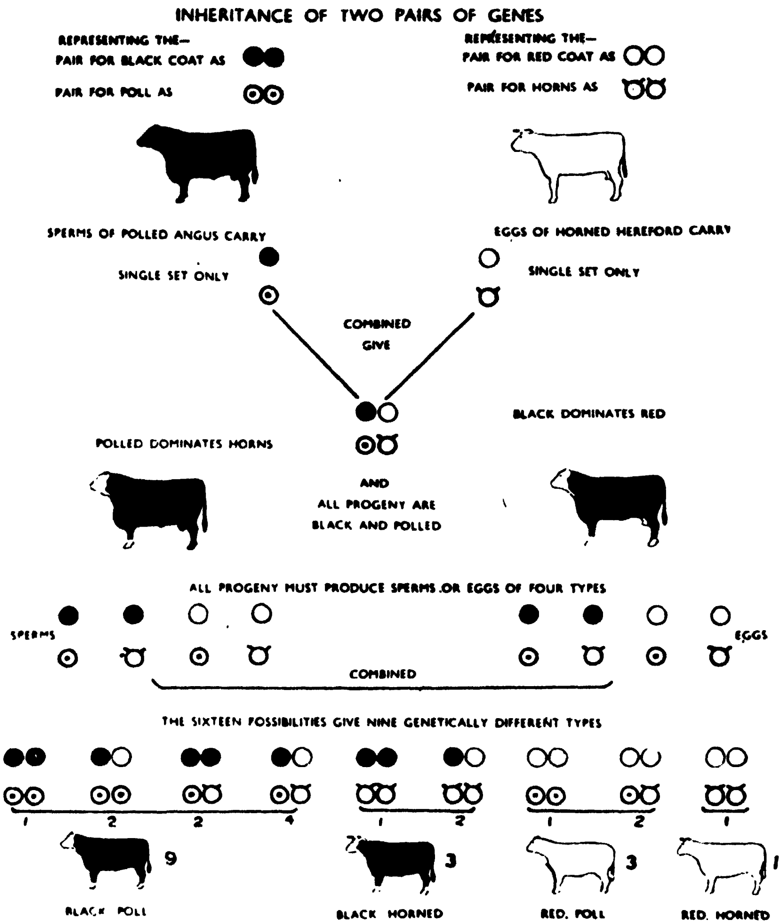
When a mating is made between the two breeds, the Aberdeen-Angus will transmit the gene for black and the Red Poll that for red coat colour. The cross-bred animal will, therefore, have one gene producing the substances necessary for black and another those for red coat colour. The beast thus has the heredity necessary for a black, a red or an intermediate coat colour. Experimental breeding shows that the gene for black coat colour continues to function and the animal is visibly indistinguishable from a pure Aberdeen-Angus.

In the terminology of the monk Mendel, who was the first to effectively study the mating of unlikes, the gene for black is "dominant" and masks the "recessive" gene for red. That the gene for red is merely masked and passes unaltered through the black beast is shown by the 25 per cent. of red animals produced by matings between such crossbreds. Genes are indestructible and cannot be altered. They can be exchanged, however, and by breeding genetically pure animals the undesirable genes can be entirely eliminated from the flock or herd. The genetically "pure" bred can transmit only one type of gene for a character, whereas the "impure" or "unfixed" beast can transmit two different genes for that character and beget two types of progeny. There is a marked difference between the genetically "pure" and the "pure breeds" of farm animals, which are usually variable among themselves and also in respect to their progeny.

"Dominance" and "recessiveness" together with the duplication of the genes make the breeding animals' behaviour uncertain and the breeder's problem is to eliminate this characteristic from his stock. To ascertain whether his Aberdeen-Angus is pure for "polled" and "black" coat colour the beast should be mated with eight or so red, horned cows. If all the progeny are polled and black, the bull is pure, but any red or horned calves will indicate that he is genetically unfixed for these characters.

Wrinkles in Merino Sheep.

In the Australian Merino sheep, the plain body type is dominant to wrinkled. Consequently two plain animals can beget wrinkled progeny, which form the majority of culls in most flocks. Austin in his excellent book on the saga of the Australian Merino, stresses the importance of this in the introduction of the very wrinkly Vermont types and the subsequent attempts which have been made to eradicate their undesirable heritage from present day flocks. He deplores also the complacency of "corrective mating" with its subsequent heavy culling, rather than the elimination of the undesirable genes, and its consequence, the absence of the wrinkly cull in flocks. The detailed genetics of wrinkle are being investigated in Australia by C.S.I.R. and also in American institutions.



The Inheritance of Commercial Production.

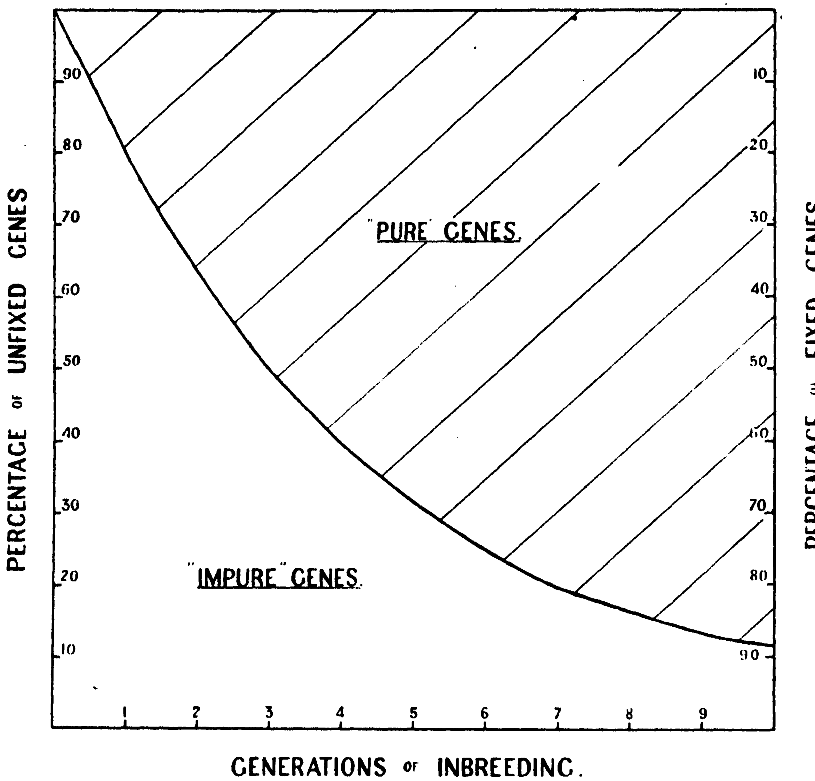
Unfortunately except in poultry, genetic research has not identified as yet, the particular genes which control commercial production such as milk yield in dairy cows. Because, unlike hair, horns, etc., they are influenced by feeding and other environmental effects, the genes governing commercial production are difficult to identify and once identified, the "fixing" of them in a strain is long and laborious. The tools which the animal breeder has available for these difficult tasks are progeny testing and inbreeding. The former was commended by the Roman writers two thousand years ago, whilst inbreeding was used most effectively by the English husbandmen who founded the prominent breeds of livestock several hundred years ago.

Breed Formation.

During the formation of most breeds there is a period of intense breeding, that is, brother-sister or repeated parent progeny mating. The famous Shorthorn bull Comet, which sold for 1,000 guineas in 1810, had only one greatgrandfather, one grandmother and his father was also his grandfather. Inbreeding is the most powerful tool in the hands of the animal breeder, since it enables gains once made by breeding to be made permanent.

GENETIC EFFECTS OF INBREEDING.

With increasing generations of inbreeding the amount of unfixed heredity in animals is greatly reduced



Ten generations of inbreeding will reduce the number of unfixed genes to a very low proportion. The greatest reduction will be in the first four or five generations.

Inbreeding.

The most noticeable result of inbreeding is the increase in uniformity of appearance and this is the outward expression of the effect of the technique on the genes. In the attached diagram it will be seen that both the genes in the Aberdeen-Angus are for "black" and in the Red Poll for "red" coat colour. As stated earlier the breeds are "pure" for these characters and all the eggs or sperm of the Aberdeen-Angus, will carry the gene for "black," and for "red" in the case of the Red Poll. The progeny of this cross will have one gene for "red" and one for "black," but the beasts would be black since that gene is, in Mendelian terminology, dominant to red. They would be genetically "impure" since they could transmit to their progeny either the gene for "black" or the gene for "red." The pure breeding beast can transmit only one type of gene to its progeny.

Matings between animals from the cross would be the first generation of inbreeding and would give both red and black animals. One half of the progeny would be "pure," however, as both their chromosomes would carry either the genes for "black" or those for "red."

Calculations indicate that there is about a 20 per cent. increase in gene purity with each generation of inbreeding so that the crossing of two animals which have fifty "unlike" or contrasting gene pairs like "red" and "black" coat colour above, will give progeny with that number of unfixed genes. Each generation of inbreeding will give a 20 per cent reduction amounting in this example, to 10 genes in the first, eight in the second, six in the third, etc., leaving 40, 32, 26, etc., unfixed genes respectively. The effects will, therefore, be most marked with the early stages of inbreeding when the greatest reduction in the number of unfixed genes will occur, the first three generations halving the number.

All the effects attributable to inbreeding are due to the increased gene purity, which accompanies it. Where animals are already highly inbred its effects will not be as marked as with nondescripts, which will have a large number of unfixed genes. Since inbreeding will give pure breeding animals which will produce beasts very similar to themselves, it makes the guides in selection, appearance, performance and pedigree much more reliable.

Inbreeding and Culling.

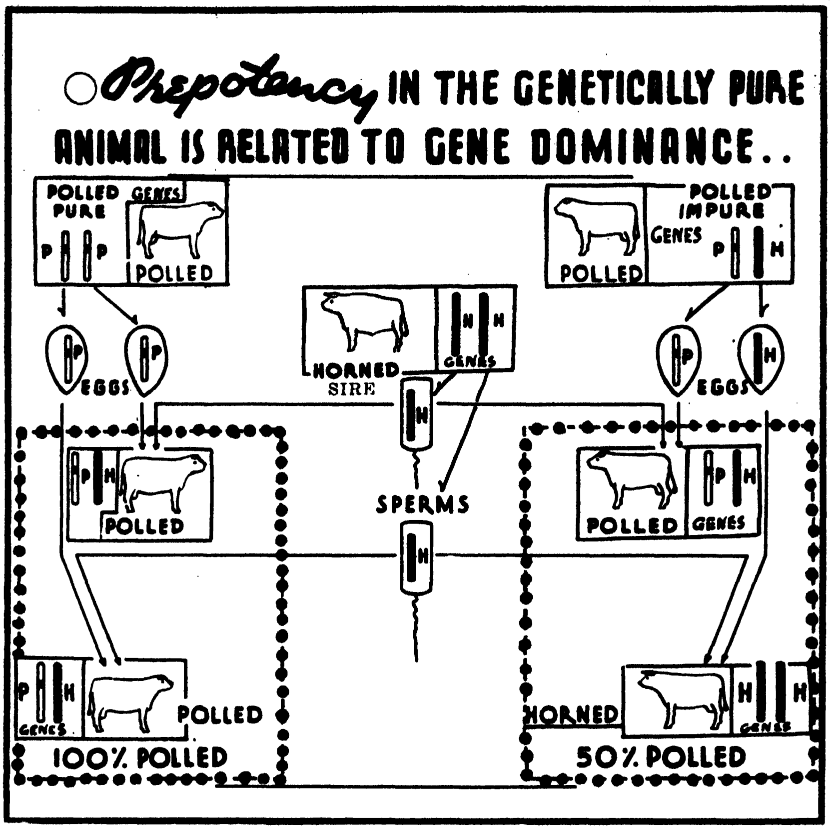
Most animal breeders avoid inbreeding, because they claim that it will be followed by a loss of vigour and perhaps fertility. Geneticists believe that vigour is related principally to the dominant genes, which by convention, are written with the capital letter. Many of these will be effective whether they are in the pure dominant AA or in the unfixed Aa condition. With inbreeding there is a marked reduction in the Aa class and an increase of those pure for the dominant AA condition or the recessive aa condition. The animals pure for the recessive may exhibit an undesirable character, such as low fertility, and if they can be culled, the trait will be removed from the flock or herd. Inbreeding does not, of itself, cause the appearance of the undesirable characters, it merely increases the proportion of animals showing them. Animal owners not in a position to cull sufficiently to eliminate the undesirables may fix unsatisfactory traits as well as favoured ones in the herd.

Inbreeding and Prepotency.

The degree to which the progeny of an animal shows the parental characters, is the measure of its "prepotency" and it is dependent on gene purity for a number of dominant characters. Pure polled animals are highly prepotent since all their progeny with the common horned animals will be polled. Impure polled animals in crosses with horned beasts would beget 50 per cent. of animals showing the recessive character "horned" and their prepotency would be correspondingly less. Prepotency is sometimes regarded as synonomous with the gene purity of "pure breeds" but it is dependent also, on dominance.

Inbreeding and Commercial Practice.

Since the inbreds are often less vigorous than the outbreds, they may not appear to be such valuable parents as the latter. The production of inbred animals, of high merit as individuals, is extremely difficult and expensive because of the intense culling required, and as the gene purity cannot be assessed by visible means, inbred animals seldom command a premium compatible with their merit as parents. Current methods of assessing animals as parents tends to under-estimate the value of the inbred and grossly over-estimate the merit of the unfixed beast.



Although the horned sire is genetically pure for this characteristic, mated with a polled animal only half of his progeny at most can be polled.

Line Breeding.

Most breeders favour line or family breeding. An endeavour is usually made to confine matings to the progeny of some famous animal, but intense inbreeding is avoided. Line breeding may mean much or little, depending on the degree of gene purity attained by previous inbreeding. The crossing of two inbred lines is similar in principle to crossing two breeds, since it usually gives animals of great merit as individuals, but with a large number of unfixed genes, which makes them unsatisfactory as foundation animals for line breeding. Such crosses between inbred lines were used successfully by English breeders to provide material for an inbreeding programme. Line breeding will not have measurable advantage over random mating unless the foundation animals have been inbred to a point where the important breed characteristics have been fixed.

Cross Breeding.

During the inbreeding associated with the formation of a breed or strain, there is some loss of the dominant genes which impart vigour. These are additive in their action and no one breed is usually as vigorous as the first generation combination of two, since one supplies dominant genes absent in the other.

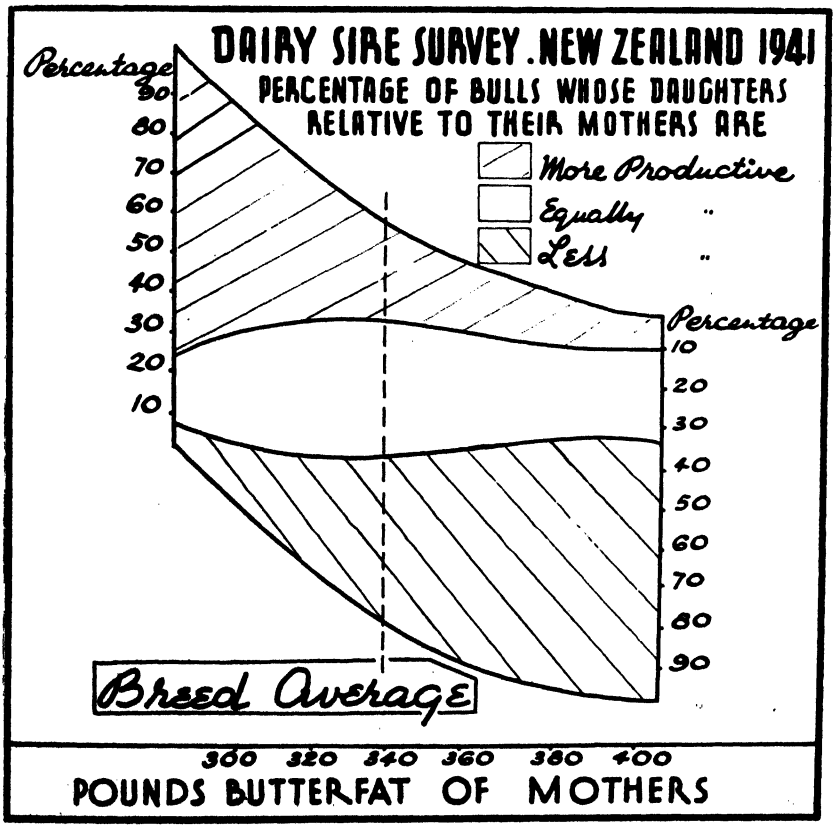
The vigour resulting from crosses between different breeds or inbred strains, will vary with the capacity of one to supply the deficiencies of the other. Because of the large number of unfixed genes in the first generation of the cross, they are not suitable for breeding, except to provide animals for the butcher.

Mating by Appearance.

The advantages of inbreeding, implying as it does mating by relationship, is that it automatically mates "like genes to like" in the most efficient manner. Environmental influences result in matings between apparently "like" animals in respect to production being between genetically "unlike" animals. When matings are between animals of similar merit in respect to production regardless of relationship, they are not likely to be effective in "fixing" the characters for which selection is being made. Progeny testing can be used, however, to markedly increase the efficiency of this type of mating, since it enables the owner to ascertain whether the characteristics which the animal exhibits are due to environment or are heritable and will be transmitted to the progeny.

Progeny Testing.

It has been shown by Lush that the demand for replacements seriously limits the scope for selection among females, particularly in the larger farm animals. The males can, however, be culled very severely and the improvement effected will be a measure largely of the accuracy with which their relative merits as sires are assessed.



Mated to cows with production above the breed average, few bulls are capable of maintaining production and still fewer of raising it.

Where the value of the male can be assessed directly as for meat and wool production, limited direct selection can be practised on the basis of growth rates and conformation. For egg and milk production, however, the male can be tested only by the merit of *all* his female progeny relative to that of their mothers.

Most animals are progeny tested eventually, and the value of the present day pedigree would be increased immeasurably by including all progeny and not just the selected superior ones.

A survey of the sires used in the New Zealand dairy industry in 1941, showed that only one bull in ten was capable of increasing the production of the daughters relative to their mothers, when they were above the average of the breed. Two out of every three bulls lowered the level of production under similar circumstances.

The average of the breed, relative to other breeds and nondescripts, is largely determined by the degree to which the genes for productivity are fixed in it. The inbreeding which characterises the early stages of breed formation "fixes" the breed average which is maintained almost unaltered by ordinary culling and selection. Without progeny testing superior cows are mated to bulls which are unable to contribute the superior genes necessary for high productivity, and the daughter's production is only average or slightly better. Progeny testing is similar in principle to prepotency for visible characters, since unless the sire is fairly pure of the genes controlling production, he will not be able to raise the level of production.

The Danish System.

The Danes sought to express merit on a tangible basis and being an eminently practical people, they concerned themselves primarily with the essential function of farm animals, that is, the conversion of feeding stuffs into meat, milk or eggs. Animals differ markedly in the efficiency with which they make the conversion and the variation is mainly due to heredity. However, under conditions of luxury feeding which exists in some Australian studs, the least efficient perform as well as the more economical animals.

The solution arrived at by the Danes to the problem of ascertaining which boars and sows produce the most efficient pigs, was to take random samples of four weaners from a litter and raise them on a standard, but adequate, ration at a central testing station. The amount of food required to produce one pound of flesh and the merit of the carcass were recorded to indicate the capacity of the parents to transmit desirable heredity to their progeny.

The breeding stations or stud farms in Denmark are privately owned, but licensed by the Government. They are frequently inspected for disease by veterinarians, and their general operations are supervised by a committee of local farmers, and others, organised on much the same lines as were our District War Agricultural Committees. The visiting committee ensures that all breeding animals are tattooed for identification purposes, and that a sound mating programme is followed, based on adequate progeny testing. Before the war, Denmark supplied about 60 per cent. of England's bacon imports and it is reasonable to assume that their elaborate system of progeny testing was profitable, since it was financed largely by the farmers themselves through their co-operatives. In Denmark only pigs which have been adequately progeny tested are eligible for Breed Registration, pedigree alone being insufficient. The Danish system ensures that purchasers of stud animals will acquire beasts capable of transmitting to their progeny the heredity necessary for efficient commercial production.

Artificial Insemination.

The most recent objective accounts available indicate that whilst at the technical level, the Russians have reached much the same point as the British, the scale upon which they use artificial insemination is almost stupendous. For 1947 it is proposed to inseminate something like 20 million sheep, a colossal task in itself. There is also evidence that the technique is being used to grade up primitive stock with more productive strains and that an elaborate system of progeny testing is practised.

Unless progeny testing accompanies artificial insemination the undesirable effects of the technique will outweigh its advantages. All sires should be progeny tested and inbred to a number of their daughters to reveal undesirable recessive genes before they are used for artificial insemination. The great value of artificial insemination is that it enables proven sires, despite their advanced age, to be widely used.

Choosing Breeding Stock.

Improvement by breeding is a long term project and should be approached cautiously. In purchasing stud animals it is desirable first to know the breeder and the degree to which he isolates his breeding stock. The continual introduction of "outside blood" may produce a few superior animals, but in the long term it increases gene variability and reduces the productivity of the strain to the level of the breed.

The Stud Animal.

In selecting a stud from which to derive animals, the purchaser would be influenced firstly by the suitability of the type to his requirements, and secondly the uniformity of its members. The aim is the purchase of gene purity and not just good looks in an animal. In a well conducted stud there will be little difference in the genetic constitution of the 1,000 guinea and the ten guinea sire, although due to environmental effects, they may look dissimilar. Studs which can provide a range of types from one extreme to the other should be avoided at all costs, since this indicates low prepotency and subsequently heavy culling.

Before the American animal husbandmen began the compilation of their Agricultural Yearbooks on heredity, published in 1936 and 1937, they anticipated that it would be comparatively easy to issue a list of breeders who could supply animals like the Danish ones, capable of giving desirable stock. Such a list would enable a farmer, by purchasing males from one source, to grade up his own animals, so that in three or four generations they would be equal, in respect to production, to the beasts of the stud from which they were bred.

In both America and Australia unfortunately, the merit of studs is assessed chiefly on the basis of show ring awards and the fabulous prices obtained for some selected animals. Show awards do not attempt to measure the capacity of animals to transmit their merit to progeny whilst sale ring prices may be, at times, a form of advertising.

The Agricultural Show.

Agricultural shows, like horseracing, have as their objective the improvement of the breed. Unfortunately, as awards are made entirely on appearance, they give minor, non-commercial characteristics, such as hair and horns, more emphasis than the production of milk or eggs. Further, they do not guarantee that the animal is capable of producing a gallon of milk or laying a dozen eggs.

Shows also set up arbitrary standards which prevent the development of pure breeding beasts and greatly increase the number of characters for which selection may be made.

In the Barred Plymouth Rock fowl for instance, the barring gene is associated with sex. This results in the pure breeding barred male being much lighter in colour than the female or the rooster impure for barring. However, because the show-ring demands that the male be dark in appearance like the female, the impure rooster will always win the award. This is despite the fact that one half of his daughters will be black and one half of his sons too light in colour for exhibition. In effect, on the basis of show standards one half of his progeny must be discarded, and this makes improvement in the commercially important characteristics such as egg production just twice as difficult. A survey would undoubtedly reveal many similar instances where compliance with show standards results in an animal which cannot reproduce itself in a large proportion of its progeny.

The creation of special classes at agricultural shows for adequately progeny tested livestock would direct attention to the first essential in a breeding animal, namely, its capacity to beget superior progeny. Awards in this section would then be a really useful guide to buyers, and breeders would be compelled by competition to make their studs functional sources of superior breeding material.

Performance as a Guide in Selection.

Performance, particularly where it is repeatable, as in egg or milk production is a valuable aid to selection, when records are available for a three to four year period.

Although many animals possess the desirable characteristics themselves, the genes are unfixed and they were unable to transmit them all to even one half of their progeny. Performance should, therefore, usually be discounted in selection, since the progeny will deviate towards the general average of the breed.

Grading up.

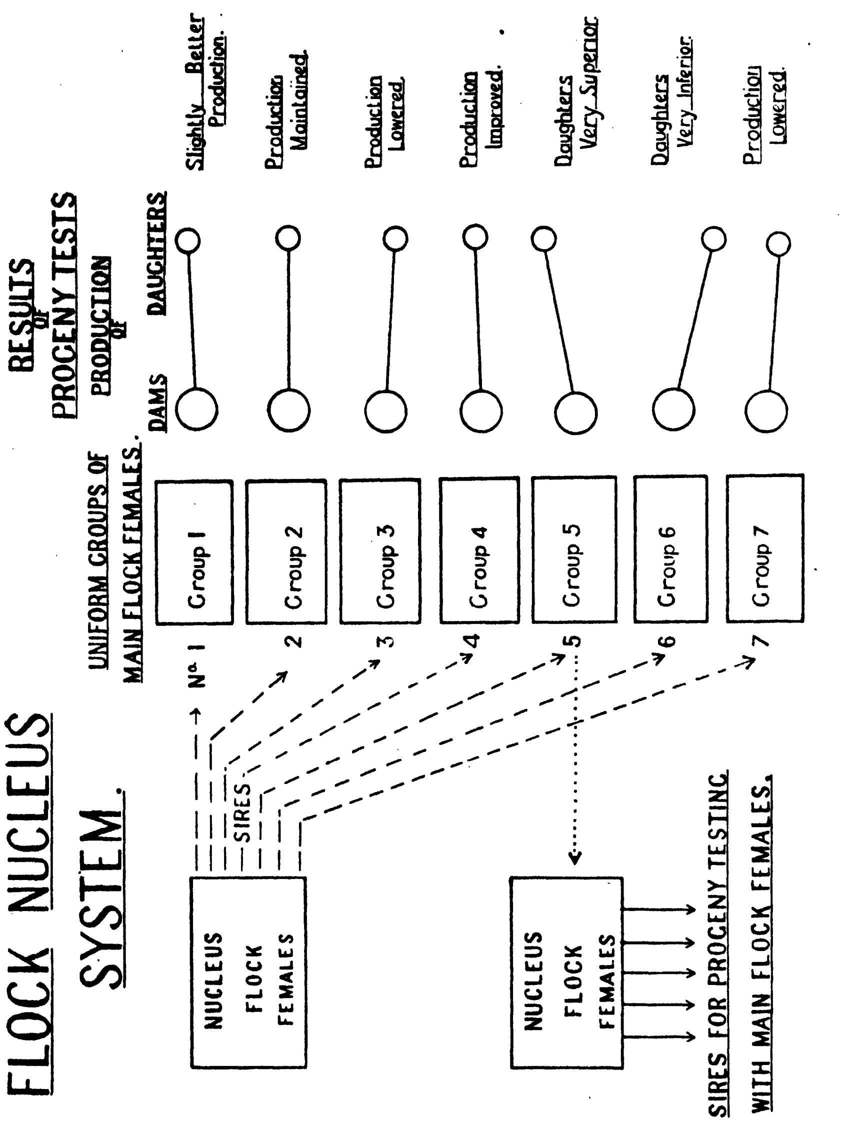
The continued use of sires of one breed on those of another or scrub animals will give, in five or six generations, a group indistinguishable from pure breds. The greatest vigour will occur in the first generation animals and the improvement in each will become progressively less. The same effects will be obtained from crosses between strains of the same breed.

Flock Nucleus System.

When introducing sires it is desirable to progeny test them on random groups before choosing one for use with the selected or nucleus females. This system of maintaining two flocks, one a main group for progeny testing sires and the other an elite group for mating only with tested animals, is advocated by Hagerdoorn and other geneticists. The effectiveness of the system will depend on the refinement possible on various farms, but it is the powerful aid to animal improvement by breeding.

The Permanence of Breed Improvement.

It may well be asked, in the case of the larger farm animals at least, whether the time, effort and expense necessary in the production of animals possessing superior heredity, is justified. However, unlike the action of environment such as feeding, which must be repeated in every generation, improvement in heredity, once effected, is permanent. It reduces or eliminates the need for culling unprofitable animals to attain a high level of production.



A nucleus of superior females which are mated only with progeny tested sires, is maintained. These matings provide the young males for progeny testing on groups of the main flock.

The greatest progress in animal breeding has probably been made with poultry. Working with Rhode Island Red birds, American breeders have developed from a flock capable of laying perhaps 100 eggs per hen, and 95 per cent. broody, one averaging 240 eggs yearly and 3 per cent. or less broody. This high egg production is repeated year after year, and is made absolutely without culling or disposal of birds, except those that die. Egg size, shell colour and texture, as well as bird size, have been improved along with production. Once the heredity of the bird is fixed or permanent for high egg production, it is only necessary to practice correct housing and feeding to ensure productivity.

By contrast, in an Australian flock, where all the pullets are tested for egg production and those which lay over 200 eggs in their pullet year are used in the breeding pens, only one half of their daughters lay 200 eggs, and the average production is only about 150. All the males used as sires are from hens which lay over 200 eggs. To attain a production of 200 eggs per bird in this flock it is, therefore, necessary to cull at least 50 per cent. of the pullets each year. Probably 70 to 80 per cent. would have to be culled to give the performance of the American birds.

Breeding and Environment.

Plant improvers have aimed at providing plants for specific environments by breeding them in the conditions which they are likely to encounter under commercial production.

Animal breeders have usually tended to carry out their selection under the most favourable conditions of luxury feeding. These are often in marked contrast to those which the animal's progeny will encounter. Enlightened breeders are tending to adopt the plant breeder's outlook, but it behoves the animal owner to make quite sure that breeding and not feeding is the limiting factor in production. The animal and its environment are inseparably related and must receive joint consideration.

SUMMARY.

Breeding animals have a dual personality inasmuch as they possess the capacity to transmit heredity of which they give no visible evidence. This is because the various characteristics may be considered as units whose expression is governed by the fundamental force in heredity, the gene.

The genes are present in a duplicate condition, since each parent contributes a complete set for each character. Many genes are "dominants" and prevent the expression of "recessive" ones when both are present in an animal. An animal which possesses unlike genes is impure for that character, and will not breed true. When the gene pair is identical only one type of gene, hence heredity can be transmitted resulting in a pure breeding animal.

Animal breeders have, in progeny testing and inbreeding, two powerful tools for lifting the level of production. Only animals which are relatively pure for the genes giving high production will perform well in progeny tests. By inbreeding, to these proven sires, the breeder can rapidly fix the genes for high production. Artificial insemination by extending the useful life of proven sires, will be a valuable aid to animal improvement by breeding.

The merit of a breeding animal is its capacity to beget high producing progeny.

Pure-Bred Herd Recording, 1945-46.

M. CULLITY, Superintendent of Dairying, and B. H. DRAKES.

THERE has been a slight increase in the number of herds under test, but this represents only a very small proportion of the total number of pure-bred herds of the three breeds in the State, which approximate 260 registered with the societies, 34 only being submitted for test.

In all the production of 424 cows was recorded; of these 31 were withdrawn for various reasons before being under test 150 days and their yields have not been included in the averages. The remaining 393 cows averaged 279.3 lbs. butter-fat, which is 9.49 lbs. below last year's average.

This is the lowest for many years and is due to many factors. A steady decline has occurred since 1941-42—this may be attributed to causes brought about by war conditions—such as shortage of labour, fertiliser and feedstuffs. The low average recorded during the past year, however, cannot be attributed to these reasons and appears to be largely due to adverse seasonal conditions.

A number of individual high herd averages were obtained and this suggests that with improved feeding and management the level of production of purebred herds can be raised appreciably within a short period.

The average production of all cows completing test since 1934 is shown in the following table.

TABLE 1.
PURE-BRED HERDS, 1934–46.

Year.	No. of Cows Completing Test.	Average Butter Fat per Cow.
		lb.
1934–35	305	320·26
1935–36	367	297·17
1936–37	319	300·87
1937–38	333	298·08
1938–39	375	292·40
1939–40	382	305·88
1940–41	372	298·38
1941–42	290	322·84
1942–43	294	321·27
1943–44	289	311·57
1944–45	344	289·42
1945–46	393	279·93

It will be seen that there has been no improvement in production during that period. This should be the cause of concern to all stud breeders who might with advantage canvas methods of improving the position.

In view of the expressed opinion that seasonal conditions were responsible for the decline in production last year, it is appropriate to add that greater attention to feeding should in the great majority of cases give an immediate improvement in yields.

The percentage of cows passing standard is given in table 2.

This table shows a very serious retrogression and again is one which should be studied carefully by breeders who submit their herds for testing.

It will be noted that in the Guernsey breed there has been a steady decline in the proportion of cows passing standard since 1939-40; with the Australian

TABLE 2.

PERCENTAGE OF COWS PASSING STANDARD.

Year.	Australian Illawarra Shorthorn.	Guernsey.	Jersey.	Total.
	%	%	%	%
1937-38	59·1	68·7	35·6	53·1
1938-39	53·8	71·4	55·2	57·9
1939-40	48·0	77·5	64·2	59·2
1940-41	52·0	61·0	51·0	54·0
1941-42	73·1	68·3	59·7	68·3
1942-43	67·6	67·9	55·0	64·3
1943-44	57·8	52·1	73·3	61·9
1944-45	52·5	43·4	72·2	57·3
1945-46	43·1	33·3	52·9	43·8

Illawarra Shorthorns the decline has been continuous since 1941-42. The percentage of all cows passing standard has fallen by 13.5 per cent. compared with the previous year, the greatest decline having occurred in the Jersey breed, which was nearly 20 per cent. below the previous proportion; the number passing standard, however, for this breed was higher than in the other two.

The number of cows passing standard and the proportion in each age group for each breed is shown in table 3.

TABLE 3.

COWS PASSING STANDARD.

Age Class.	A.I.S.		Guernsey.		Jersey.		All Breeds.	
	No. of Cows Tested.	No. Passing Standard.	No. of Cows Tested.	No. Passing Standard.	No. of Cows Tested.	No. Passing Standard.	No. of Cows Tested.	No. Passing Standard.
Mature	41	15	48	12	42	14	131	41
Senior 4 years	12	4	5	1	10	6	27	11
Junior 4 years	8	1	5	2	9	6	22	9
Senior 3 years	17	7	10	2	12	9	39	18
Junior 3 years	22	2	11	2	17	11	50	15
Senior 2 years	26	11	10	6	14	6	50	23
Junior 2 years	57	39	16	10	32	20	105	69
Total	183	79	105	35	136	72	424	186
Percentage	43·1		33·3		52·9		43·8	

The only pleasing feature in this table is the relatively better performance recorded by the Junior two-year-old cows.

It will be noted that the mature cows for an unexplained reason have been particularly disappointing.

In the Mature class, the Jersey cows were the only ones which showed a higher average than last year. In the Senior three-year-old class the Shorthorns and Jerseys showed improved figures. In the Senior two-year-olds the Guernseys had an increased average, while in the Junior two-year-old class the Shorthorns and Guernseys recorded an improvement with the Jerseys registering a fall in production.

A comparison between the yields of all cows under test more than 150 days and those of cows which completed 273 days is shown in table 5. The information is tabulated according to breed and age class.

TABLE 4.

AVERAGE BUTTER FAT PRODUCTION IN EACH CLASS.

Age Class.	A.I.S.			Guernsey.		Jersey.		All Breeds.	
	Standard required.	No. of Cows.	Average Butter Fat.	No. of Cows.	Average Butter Fat.	No. of Cows.	Average Butter Fat.	No. of Cows.	Average Butter Fat.
	lb.		lb.		lb.		lb.		lb.
Mature	350	39	294·12	44	284·86	33	345·02	116	305·09
Senior 4 years	330	12	274·64	4	294·16	10	338·65	26	302·34
Junior 4 years	310	8	234·93	5	316·95	9	330·75	22	292·77
Senior 3 years	290	17	253·17	9	257·08	12	361·96	38	288·45
Junior 3 years	270	21	210·28	10	220·27	16	335·58	47	255·06
Senior 2 years	250	25	236·92	9	291·85	11	254·43	45	252·19
Junior 2 years	230	55	259·76	16	266·91	28	266·62	99	262·86
		177		97		119		393	

TABLE 5.

COMPARATIVE TABLE SHOWING AVERAGE PRODUCTION IN EACH AGE CLASS OF COWS UNDER TEST 150 DAYS OR OVER AND COWS COMPLETING 273 DAYS

Age Class.	Standard Butter Fat.	A.I.S.				Jersey.			
		No. of Cows Tested 150 days or over.	Average Butter Fat.	No. of Cows Completing 273 days.	Average Butter Fat.	No. of Cows Tested 150 days or over.	Average Butter Fat.	No. of Cows Completing 273 days.	Average Butter Fat.
	lb.		lb.		lb.		lb.		lb.
Mature	350	39	294·12	26	345·90	33	345·02	24	383·13
Senior 4 years	330	12	274·64	10	287·06	10	338·65	8	385·33
Junior 4 years	310	8	234·93	5	299·63	9	330·75	3	348·83
Senior 3 years	290	17	253·17	11	282·30	12	361·96	12	361·96
Junior 3 years	270	21	210·28	8	239·48	16	335·58	13	353·57
Senior 2 years	250	25	236·92	14	275·46	11	254·43	8	275·13
Junior 2 years	230	55	259·76	46	281·42	28	266·62	24	273·43

Age Class.	Standard Butter Fat.	Guernsey.				All Breeds.			
		No. of Cows Tested 150 days or over.	Average Butter Fat.	No. of Cows Completing 273 days.	Average Butter Fat.	No. of Cows Tested 150 days or over.	Average Butter Fat.	No. of Cows Completing 273 days.	Average Butter Fat.
	lb.		lb.		lb.		lb.		lb.
Mature	350	44	284·86	34	315·88	116	305·09	84	343·19
Senior 4 years	330	4	294·16	2	338·17	26	302·34	20	331·48
Junior 4 years	310	5	316·95	3	337·49	22	292·96	11	323·38
Senior 3 years	290	9	257·08	5	282·96	38	288·45	28	316·56
Junior 3 years	270	10	220·27	5	269·30	47	255·06	26	303·80
Senior 2 years	250	9	291·85	8	315·51	45	252·19	30	276·05
Junior 2 years	230	16	266·91	14	277·01	99	262·86	84	278·40

It will be noted in each case—as would be expected—that the averages of those cows completing the full 273 days were considerably higher than the average, including those which completed their lactations in a lesser time.

Of the 393 cows included in the averages, 283—or 72 per cent. only—completed the full 273 day testing period.

It is pleasing to record that in the case of the Jersey cows, the average for each age-class for those completing a full period was higher than the standard for the class. The mature Guernsey cows and all classes of Shorthorns with the exception of the two-year-olds did not reach the standard.

Leading Sires.

The three leading sires for the year were "Austral Park Wonderful Standard" owned by Miss Hancock, "Mornmoot Northwood Beau," owned by R. H. Rose and Son, and "Summerlea Churchill," owned by the Claremont Hospital for the Insane.

The adjusted average for the production of the six best daughters in each case was 573.2 lbs., 527.9 lbs., and 422.5 lbs. butter-fat respectively.

Details of the average for the selected and for all daughters are shown in table 6.

In table 7 are given the performances of the three best sires for the years 1943-44, 1944-45 and 1945-46:—"Austral Park Wonderful Standard," "Mornmoot Northwood Beau," and "Grass Vale Gold Boy"—the average age-adjusted-yield of the daughters of these bulls for the three years being 517.6, 487.6 and 480.1 lbs. respectively.

These productions are very pleasing and indicate careful management on the part of the herd-masters in each case.

Leading Cows.

The productions of the leading three cows in each age class are shown in table 8.

New Records.

New records were established by three Jersey cows.

Junior Three-year-old Class, Jerseys.

"Juadine Peerless Lily 20th," owned by Miss L. G. Hancock of Harvey, produced 8,976 lbs. milk, average test 6.10 per cent., 547.67 lbs. butter-fat, thus exceeding the production of the previous holder of this record, "Camden Ariadne" owned by Mr. C. E. Kruger, of Pinjarra, whose figures were 7,980 lbs. milk, average test 6.65 per cent., and 530.88 lbs. butter-fat.

"Juadine Peerless Lily 20th" did not hold this record for long as it was later exceeded by over 100 lbs. by the cow "Grass Vale Northwood Eve," owned by Messrs. R. H. Rose and Son of Burekup, who produced 11,511 lbs. milk, average test 5.69 per cent., and 655.15 lbs. of butter-fat, thus establishing new records in the following classes:

Junior three-year-olds—Jersey.
Junior three-year-olds—All breeds.
Junior three-year-olds—West Australian bred.

Mature Class, Jerseys.

"Juadine Peerless Lily 13th" gained yet another success by exceeding the previous record in this class with 10,510 lbs. milk, average test 6.48 per cent., and 681.73 lbs. butter-fat.

The previous record had been held since 1934 by "Banyule Silvermine 55th," whose production was 11,759 lbs. milk, average test 5.76 per cent. and 677.97 lbs. butter-fat.

"Juadine Peerless Lily 13th" now holds seven State records:—

- Mature cow class—Jersey breed.
- Senior four-year-old—Jersey breed, West Australian bred, and all breeds.
- Senior three-year-old—Jersey breed, West Australian bred, and all breeds.

TABLE 6.

LEADING THREE SIRES.

Name of Bull.	Owner.	Sire.	Dam.	Average Production of six best daughters.		Number of daughters under test.	Average Production.	
				Without allowances (lbs. butter fat).	With allowances (lbs. butter fat).		Without allowances (lbs. butter fat).	With allowances (lbs. butter fat).
Austral Park Wonderful Standard (Jersey, (12423)	... ...	Ellerdale Wonderful Masterman (11561)	Ellerdale Wonder's Golden (47992)	525·91	573·23	8	475·18	517·61
Mornmoot Northwood Beau (Jersey) (17798)	R. H. Rose & Son	Glen Iris Golden Beau (14629)	Mornmoot Northwood Madeira 7th (63202)	466·18	527·99	10	410·41	481·72
Summerlea Churhill (A.I.S.) (6236)	Claremont Hospital for Insane	Summerlea Togo (1527)	Summerlea Empress 7th (14247)	326·40	422·55	12	298·24	391·37

TABLE 7.

AVERAGE PRODUCTION OF DAUGHTERS OF THE LEADING THREE HERD SIRES, 1943–44 to 1945–46.

Name of Bull.	Sire	Dam.	Average Production of Six Best Daughters.		No. of Daughters Tested.	Average Production.	
			Without allowances (lbs. butter fat).	With allowances (lbs. butter fat).		Without allowances (lbs. butter fat).	With allowances (lbs. butter fat).
Austral Park Wonderful Standard (Jersey) 12423	Ellerdale Wonderful Masterman 11561	Ellerdale Wonder's Golden 47992	569·88	619·32	14	470·06	517·57
Mornmoot Northwood Beau (Jersey) 17798	Glen Iris Golden Beau 14629	Mornmoot Northwood Madeira 7th 63202	474·04	590·33	19	393·33	487·63
Grass Vale Gold Boy (Jerssey) 14684	Belgonia Gold Boy 12458	Grass Vale Lady Fowler 17th 48536	464·90	519·08	12	436·51	480·08

TABLE 8.

THREE LEADING COWS IN EACH AGE CLASS, 1945–46.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight Last Day of Test.	Weight of Milk for Period.	Average Test.	Weight of Butter Fat for Period.	Owner	Sire.
MATURE COWS—STANDARD 350 LB. BUTTERFAT.											
							lb.	%	lb.		
Juadine Peerless Lily 13th	Jersey	76977	20–12–38	25–8–45	273	28·5	10,510	6·48	681·73	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Camden Circe	Jersey	80637	24–9–39	9–10–44	273	18	9,234	6·93	640·20	C. E. Kruger	Greenmount Golden Sultan (14688)
Congelin Rosemarie 6th	Jersey	80830	14–4–40	9–6–45	273	14	9,267	6·20	575·07	D. Bradford	Rosecliffe Marchalong (15094)
SENIOR FOUR YEAR OLDS—STANDARD 330 LB. BUTTERFAT.											
Juadine Queen	Jersey	87022	20–5–40	1–2–45	273	29·5	8,968	6·37	571·69	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Grass Vale Lady Fowler 31st	Jersey	81634	17 8–40	6–5–45	273	23	9,069	5·31	481·94	R. H. Rose & Son	Grass Vale Gold Boy (14684)
Koojan Golden Jewel	Guernsey	8805	12–3–40	21–1–45	273	18	7,134	6·07	433·22	A. W. Padbury	Koojan Beau Ideal (4965)
JUNIOR FOUR YEAR OLDS—STANDARD 310 LB. BUTTERFAT.											
Koojan Ideal's Judith	Guernsey	10696	24–6–40	19–12–44	273	15	8,145	5·34	435·68	A. W. Padbury	Glenburnie Ideal (Imp.) (2548)
Grass Vale Lady Fowler 32nd	Jersey	86644	11–6–41	5–8–45	273	16	8,178	5·31	434·71	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Carbanup Dora	A.I.S.	35388	1–4–41	25–6–45	273	9·5	11,531	3·72	429·61	D. H. Bell	Glanavon Maestro
SENIOR THREE YEAR OLDS—STANDARD 290 LB. BUTTERFAT.											
Juadine Peerless Lily 19th	Jersey	....	26–10–41	20–5–45	273	23	8,039	6·27	503·05	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Grass Vale Golden Cream 25th	Jersey	....	7–5–41	5–5–45	273	15	7,425	6·12	455·14	R. H. Rose & Son	Grass Vale Gold Boy (14684)
Grass Vale Lady Fowler 33rd	Jersey	....	7–7–41	6–5–45	273	20	8,220	5·51	453·06	R. H. Rose & Son	Mornmoot Northwood Beau (17798)

JUNIOR THREE YEAR OLDS—STANDARD 270 LB. BUTTERFAT.

Grass Vale Northwood Eve	Jersey	....	3-7-42	2-9-45	273	27	11,511	5·69	655·15	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Juadine Peerless Lily 20th	do.	....	10-12-41	4-5-45	273	27	8,976	6·10	547·67	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Grass Vale Lady Fowler 35th	do.	....	1-3-42	23-6-45	273	14	7,182	5·97	428·86	R. H. Rose & Son	Mornmoot Northwood Beau (17798)

SENIOR TWO YEAR OLDS—STANDARD 250 LB. BUTTERFAT.

Koojan Ace's Gladsome	Guernsey	....	24-3-43	29-9-45	273	34	8,982	5·01	450·72	A. W. Padbury	Homestead Ace (Imp.) (1631)
Grass Vale Lady Fowler 36th	Jersey	....	28-5-42	20-5-45	273	21	7,788	5·72	445·41	R. H. Rose & Son	Grass Vale Gold Boy (14684)
Koojan Ideal's Noblemark's Bo Peep	Guernsey	....	19-12-42	31-8-45	273	30	8,610	5·02	432·31	A. W. Padbury	Koojan Ideal's Noblemark (5949)

JUNIOR TWO YEAR OLDS—STANDARD 230LB. BUTTERFAT.

Grass Vale Magnolia 5th	Jersey	....	16-10-43	1-10-45	273	23	7,269	5·82	423·48	R. H. Rose & Son	Grass Vale Gold Cup
Grass Vale Golden Cream 26th	do.	....	3-8-43	19-6-45	273	15	6.315	6·07	383·86	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Grass Vale Buttercup 14th	do.	....	7-9-43	2-10-45	273	17	6,441	5·93	382·00	R. H. Rose & Son	Grass Vale Gold Cup

TABLE 9.

COWS WHICH COMPLETED TEST DURING THE TWELVE MONTHS ENDED 30TH JUNE, 1946.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight of Milk Last Day of Test. lb.	Weight of Milk for Period. lb.	Average Test. %	Weight of Butter Fat for Period. lb.	Owner.	Sire.
COWS UNDER 2½ YEARS—STANDARD 230 LB BUTTER-FAT.											
Grass Vale Magnolia 5th	Jersey	....	16-10-43	1-10-45	273	23	7,269	5·82	423·48	R. H. Rose & Son	Grass Vale Gold Cup
Grass Vale Golden Cream 26th	Jersey	....	3-8-43	19-6-45	273	15	6,315	6·07	383·86	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Grass Vale Buttercup 14th	do.	....	7-9-43	2-10-45	273	17	6,441	5·93	382·00	R. H. Rose & Son	Grass Vale Gold Cup
Lansdowne Magnificent	Guernsey	....	17-3-43	10-9-45	273	26	7,578	4·81	264·77	J. R. Giles	Lansdowne Ferdinand's Polygamous (5966)
Juadine Peerless Lily 21st	Jersey	....	5-9-42	2-12-44	273	10·5	5.236	6·86	359·29	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Mayvale Discover's Bluebell 2nd	Guernsey	....	24-9-43	24-9-45	273	14	6,072	5·87	356·71	R. J. Giles	Koojan Ideal's Discover (4968)
Denmark Bonnie Princess	do.	....	28-11-42	30-4-45	273	18·5	7.300	4·73	345·65	Denmark Research Station	Koojan Ideal's Reflection (4974)
Lansdowne Ideal's Pride	do.	....	9-1-43	6-4-45	273	20	5,430	6·33	343·98	J. R. Giles	Koojan Beau Ideal (4965)
Carbanup Florence	A.I.S.	....	13-2-43	7-8-45	273	22	8,991	3·81	343·17	D. H. Bell	Glanavon Maestro (4833)
Carbanup Fuchsia	do.	....	16-2-43	15-7-45	273	6	9,093	3·69	336·44	D. H. Bell	Newstead Royal Sun (7252)
Carbanup Fragrance	do.	....	10-2-43	22-6-45	273	11·5	8,104	4·13	334·85	D. H. Bell	Newstead Royal Sun (7252)
Claremont Clara 19th	do.	....	7-9-42	16-1-45	273	30	8,580	3·88	336·16	Claremont Hospital for Insane	Summerlea Churchill (6236)
Claremont Biddy 65th	do.	....	13-9-42	26-12-44	273	32	8,196	4·05	332·55	Claremont Hospital for Insane	Summerlea Churchill (6236)
Claremont Maggie Morrison 48th	do.	....	6-8-42	23-10-44	273	32	8,406	3·88	326·93	Claremont Hospital for Insane	Summerlea Churchill (6236)
Juadine Fairy	Jersey	....	12-6-43	5-6-45	273	9	4,752	6·76	326·66	Miss L. G. Hancock	Juadine Northwood Beau (19679)
Koojan Ace's Diplomat	Guernsey	....	28-8-43	23-8-45	273	22	5.976	5·44	325·38	A. W. Padbury	Homestead Ace (1631)
Claremont Mabel 26th	A.I.S.	....	23-11-42	23-2-45	273	29	9,842	3·28	324·38	Claremont Hospital for Insane	Summerlea Churchill (6236)
Claremont Poppy 27th	do.	....	22-9-42	8-11-45	273	27	8.271	3·91	323·72	Claremont Hospital for Insane	Summerlea Churchill (6236)
Claremont Maggie Morrison 49th	do.	....	26-8-42	26-10-44	273	26	7,818	4·11	321·58	Claremont Hospital for Insane	Westby Monarch (5404)
Grass Vale Design's Noella	Jersey	....	20-10-43	26-9-45	273	16	5.868	5·45	320·28	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Claremont Whitby Maid 51st	A.I.S.	....	30-8-42	29-10-44	273	30	8,100	3·88	314·68	Claremont Hospital for Insane	Summerlea Churchill (6236)
Eangella Faline	Jersey	....	4-5-43	17-5-45	273	15	5,790	5·42	313·96	D. G. Spark	Travalgon Starbright King (18129)
Claremont Fancy 13th	A.I.S.	....	23-11-42	4-4-45	273	28	8,184	3·78	309·61	Claremont Hospital for Insane	Summerlea Churchill (6236)
Eungella Telopia	Jersey	....	20-5-43	3-7-45	273	12	5.016	6·16	309·37	D. G. Spark	Travalgon Starbright King (18129)
Carbanup Florrie	A.I.S.	....	25-6-43	9-7-45	273	13	8.919	3·43	306·05	D. H. Bell	Glanavon Maestro (4833)
Claremont Cherry 24th	do.	....	20-3-41	21-6-43	273	26	7.908	3·82	302·79	Claremont Hospital for Insane	Westby Monarch (5404)
Mayvale Diana 2nd	Guernsey	....	9-8-43	8-9-45	273	19	6,357	4·73	301·16	R. J. Giles	Koojan Ideal's Discoverer (4968)

Claremont Fancy 12th	A.I.S.	....	24-7-42	20-10-44	273	26	7,668	3·87	296·93	Claremont Hospital for Insane	Westby Masterpiece (5403)
Tipperary Fairy 9th	do.	....	27-9-42	22-12-44	273	19	6,597	4·47	295·22	W. G. Burges	Tipperary Ace (6336)
Carbanup Floxy	do.	....	19-2-43	21-6-45	273	7	7,881	3·78	293·96	D. H. Bell	Newstead Royal Sun (7252)
Claremont Maggie Morrison 51st	do.	....	28-9-42	25-1-45	273	26	7,368	3·96	292·37	Claremont Hospital for Insane	Westby Masterpiece (5403)
Tipperary Beauty 15th	do.	....	15-10-42	27-11-44	273	20	6,810	4·28	291·84	W. G. Burges	Tipperary Ace (6336)
Wooroloo Patsy 2nd	do.	....	3-8-43	26-9-45	273	19	6,537	4·44	290·27	Wooroloo Santorium Farm	Berry Rufus 2nd (6570)
Claremont Maggie Morrison 50th	do.	....	25-9-42	29-2-45	273	18	7,284	3·98	290·08	Claremont Hospital for Insane	Summerlea Churchill (6236)
Lansdowne Iolanthe	Guernsey	....	23-10-42	26-4-45	273	14	5,492	5·26	289·30	P. G. Hampshire & Son	Yarraview Clarinet 2nd (4629)
Claremont Pinafore 16th	A.I.S.	....	10-9-42	6-1-45	273	20	7,500	3·84	288·12	Claremont Hospital for Insane	Westby Monarch (5404)
Claremont Star 32nd	do.	....	11-10-42	26-1-45	273	28	7,554	3·76	384·61	Claremont Hospital for Insane	Westby Masterpiece (5403)
Claremont Beanie 12th	do.	....	5-8-42	23-10-44	273	23	7,089	4·00	283·86	Claremont Hopital for Insane	Westby Monarch (5404)
Claremont Biddy 66th	do.	....	23-9-42	24-1-45	273	19	7,002	4·02	281·87	Claremont Hospital for Insane	Westby Masterpiece (5403)
Claremont Blossom 42nd	do.	....	29-8-42	26-10-44	273	28	6,864	4·09	281·03	Claremont Hospital for Insane	Summerlea Churchill (6236)
Glanavon Spangle 3rd	do.	36583	1-9-42	16-11-44	273	21·5	6,285	4·39	278·76	W. G. Burges	Blacklands Monarch's Commander (1877)
Wooroloo Gait	do.	....	28-2-43	26-2-45	273	24	6,282	4·42	278·09	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Juadine March Flower 2nd	Jersey	....	30-9-43	4-9-45	240	12	4,650	5·93	276·15	Miss L. G. Hancock	Juadine Northwood Beau (17798)
Camden Charmaine	do.	....	11-7-43	28-7-45	273	5·5	4,906	5·61	275·36	Mrs. A. G. Eckersley	Greenmount Golden Bobbie (18578)
Kapara Viola	do.	....	27-4-43	28-8-45	273	7·5	5,182	5·30	274·80	D. Bradford	Congelin Mandarin (14542)
Claremont Belle 32nd	A.I.S.	....	8-8-42	23-10-44	273	23	6,459	4·24	274·15	Claremont Hospital for Insane	Westby Monarch (5404)
Claremont Beauty 25th	do.	....	17-12-42	27-5-45	273	24	6,912	3·96	273·74	Claremont Hospital for Insane	Summerlea Churchill (6236)
Claremont Beauty 26th	do.	....	23-6-43	28-8-45	273	10	7,050	3·87	273·23	Claremont Hospital for Insane	Westby Monarch (5404)
Brookfield's Isobel	Guernsey	....	15-4-43	7-10-45	273	7·5	5,527	4·89	270·29	P. G. Hampshire & Son	Yarraview Julian (4634)
Claremont Maggie Morrison 53rd	A.I.S.	....	1-2-43	12-6-45	273	23	6,669	4·03	269·02	Claremont Hospital for Insane	Westby Monarch (5404)
Wattlecreek Stella	do.	....	22-9-42	23-10-44	273	24	6,732	3·98	268·45	E. T. Thatcher	Wattlecreek Duchess's Monarch (5399)
Claremont Whitby Maiden 3rd	do.	....	3-11-42	12-1-45	273	21	6,993	3·81	266·57	Claremont Hospital for Insane	Westby Masterpiece (5403)
Carbanup Floss	do.	....	22-4-43	23-7-45	273	7	7,296	3·56	260·14	D. H. Bell	Newstead Royal Sun (7252)
Carbanup Freda	do.	....	8-7-43	25-7-45	273	4·5	6,928	3·74	259·23	D. H. Bell	Newstead Royal Sun (7252)
Travalgon Starbright 21st	Jersey	....	27-5-43	15-6-45	273	12	4,221	6·13	258·80	W. H. & T. F. Robinson	Orphanage Cuba (17913)
Tipperary Lovely 6th	A.I.S.	....	14-9-42	23-11-44	273	18	6,324	4·08	258·53	W. G. Burges	Tipperary Ace (6336)
Claremont Cherry 29th	do.	....	3-6-42	20-10-44	273	20	6,135	4·20	258·09	Claremont Hospital for Insane	Westby Monarch (5404)
Crantock Fancy Bonnette	Jersey	....	18-4-43	18-3-45	273	16·5	4,939	5·09	251·83	Mrs. G. H. Burnside	Werribee David (18183)
Radyr Park Coon's Coronation's Estrellita 5th	do.	....	1-8-43	6-10-45	273	12	4,176	6·02	251·59	L. M. Temple	Navua September Lad (14023)
Brookfield's Faith 13th	Guernsey	....	26-9-43	14-9-45	273	10	4,695	5·32	249·98	P. G. Hampshire & Son	Yarraview Julian (4634)

TABLE 9—HERD TESTING—continued.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight of Milk Last Day of Test. lb.	Weight of Milk for Period. lb.	Average Test. %	Weight of Butter Fat for Period. lb.	Owner.	Sire.
COWS UNDER 2½ YEARS—STANDARD 230 LB BUTTER-FAT—*continued.*											
Korigekup Loyal Lady	Jersey	....	25–2–43	24–6–45	273	8	5,214	4·75	248·01	Mrs. A. G. Eckersley	Navua Royal Star (15869)
Travalgon Lady Eion 17th	do.	....	29–5–43	17–7–45	273	11	4.248	5·81	247·13	W. H. & T. F. Robinson	Orphanage Douglas (18919)
Lansdowne Pollyanna 2nd ...	Guernsey	10725	16–9–42	25–12–44	210	16	4,080	5·97	243·60	J. R. Giles	Koojan Beau Ideal (4965)
Camden Selena	Jersey	....	28–9–43	21–6–45	273	11	4,338	5·60	243·00	D. G. Spark	Greenmount Golden Bobbie (18578)
Wooroloo Hilda	A.I.S.	....	27–12–42	25–12–44	273	20	5,835	4·15	242·71	Woorlooo Sanatorium Farm	Berry Rufus 2nd (6570)
Crantock Masterpiece's Maptionette	Jersey	....	3–5–43	26–7–45	240	7	4,830	4·98	240·84	Mrs. G. H. Burnside	Crantock Napoleon's Masterpiece (14550)
Travalgon Starbright 20th	do.	....	15–4–43	13–7–45	273	13	4,104	5·78	237·32	W. H. & T. F. Robinson	Orphanage Cuba (17913)
Camden Celeste	do.	....	10–9–43	9–4–45	273	10	3,705	6·33	234·60	D. G. Spark	Greenmount Golden Bobbie (18578)
Wattlecreek Scarlet	A.I.S.	....	16–8–42	7–10–44	273	16	5,508	4·23	233·31	E. T. Thatcher	Wattlecreek Duchess's Monarch (5309)
Kapara Bo-Peep	Jersey	....	17–5–43	17–7–45	273	9	4,617	4·91	226·88	D. Bradford	Congelin Jolly Eminent 3rd (82073)
Brookfield's Ballet Girl	Guernsey	....	12–10–42	16–1–45	273	23·5	5,335	5·24	226·73	P. G. Hampshire & Son	Yarraview Clarinet (4629)
Claremont Biddy 72nd	A.I.S	....	24–8–43	25–9–45	273	17	5,721	3·94	225·61	Claremont Hospital for Insane	Westby Masterpiece (5403)
Juadine Lily	Jersey	....	12–2–43	8–6–45	273	10	4,070	5·52	224·83	Mrs. A. G. Eckersley	Austral Park Wonderful Standard (12423)
Travalgon Starbright 24th	do.	....	12–8–43	12–7–45	273	13	4,004	5·09	224·49	W. H. & T. F. Robinson	Orphanage Douglas (18919)
Wooroloo Emerald	A.I.S.	....	30–11–42	18–12–44	273	15	4,965	4·51	224·19	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Glanavon Doris 15th	do.	....	21–10–42	15–2–45	273	23	5,379	4·15	223·40	D. Bevan & Sons	Blackland Monarch's Commande (1877)
Lansdowne Bonny Elizabeth	Guernsey	....	1–6–42	11–11–44	273	7	3,956	5·62	222·55	J. R. Giles	Koojan Beau Ideal (49645)
Claremont Poppy 29th	A.I.S.	....	16–3–43	8–6–45	273	15	5,475	4·06	222·51	Claremont Hospital for Insane	Summerlea Churchill (6236)
Claremont Lily 11th	do.	....	3–1–43	9–4–45	273	18	5,574	3·97	221·54	Claremont Hospital for Insane	Westby Monarch (5404)
Travalgon Starbright 23rd	Jersey	....	27–6–43	11–8–45	240	13	3,750	5·55	208·20	W. H. & T. F. Robinson	Orphanage Douglas (18919)
Travalgon Lady Eion 18th	do.	....	30–5–43	14–7–45	273	8	3,249	6·10	198·36	W. H. & T. F. Robinson	Orphanage Cuba (17913)
Wattle Creek Rene	A.I.S.	....	21–8–43	20–6–45	273	15	5,175	3·82	198·14	E. T. Thatcher	Glanavon Duncan
Narrogin Marrion	do.	....	10–6–43	12–4–45	273	12	4,851	4·07	197·14	Narrogin School of Agriculture	Tipperary Amy's Mascot (6338)
Muresk's Delicia's Pride	Guernsey	....	11–6–43	9–6–45	273	11	4,203	4·66	196·01	Muresk Agricultural College	Koojan Ace Warspite (5943)
Carbanup Fussy	A.I.S	....	22–8–43	1–8–45	240	2	5,055	3·87	195·87	D. H. Bell	Glanavon Maestro (4833)

Denmark Orange Pekette	Guernsey	....	12–6–43	28–6–45	273	6	4,443	4·37	194·38	Denmark Research Station	Koojan Ideal's Reflection (4974)
Muresk Gay	do.	....	29–3–43	29–8–45	273	10	3,630	5·26	191·30	Muresk Agricultural College	Koojan Ideal's Dictator (4167)
Wooroloo Lucky	A.I.S	....	4–8–43	27–9–45	240	8	4,170	4·35	181·80	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Kapara Fire-fly	Jersey	....	11–8–43	2–9–45	180	15	3,960	4·48	177·75	D. B. Radford	Congelin Mandarin (14542)
Travalgan Lady Mint 9th	do.	....	28–7–43	24–6–45	273	5	3,360	5·19	174·50	W. H. T. F. Robinson	Orphanage Douglas (18919)
Narrogin Flo	A.I.S.	....	6–4–43	15–5–45	240	11	5,670	3·06	173·73	Narrogin School of Agriculture	Tipperary Amy's Mascot (6338)
Travalgan Starbright 22nd	Jersey	....	18–6–43	17–6–45	273	9	3.147	5·46	171·97	W. H. & T. F. Robinson	Travalgan Oxford's King (19160)
Wattle Creek Rivette	A.I.S.	....	23–9–42	4–11–44	210	13	3,840	3·92	150·90	E. T. Thatcher	Wattle Creek Duchess's Monarch (5399)
Denmark Reflections' Dame	Guernsey	....	15–2–43	30–4–45	240	6·5	3,345	4·44	148·83	Denmark Research Station	Koojan Ideal's Reflection (4974)
Glanavon Charmer 3rd	A.I.S.	....	29–12–42	9–1–45	240	14	3.480	4·01	139·89	D. Bevan Sons	Blackland's Jean's Supreme (1871)
Narrogin Dora	do.	....	1–7–43	17–5–45	210	6·5	3,435	3·86	132·81	Narrogin School of Agriculture	Tipperary Amy's Mascot (6338)
Lenmoor's Rosy	do.	....	18–8–43	11–10–45	180	10	3,480	3·67	127·86	W. K. Barnes	Ferndale Radiant (5729)
Glanavon Melba 6th	do.	....	22–12–42	17–1–45	240	14	3,030	4·04	122·52	D. Bevan Sons	Glanavon Federal (6869)
Lenmoor's Roma	do.	....	16–8–43	16–10–45	180	6	3,090	3·76	116·46	W. K. Barnes	Ferndale Radiant (5729)
Juadine Julienne 3rd	Jersey	....	19–8–43	18–8–45	90	22	2.025	5·45	110·49	B. Langridge	Juadine Northwood Beau (19679)
Crantock Fancy Primula	do.	....	7–12–43	13–2–46	60	18	1,230	4·49	55·26	Mrs. G. H. Burnside	Werribee David (18183)
Radyr Park-Dorothy 24th	do.	....	28–3–44	21–3–46	60	13	870	5·20	45·27	L. M. Temple	Navua September Lad (14023)
Sarsden Gem	A.I.S.	....	6–10–43	27–2–46	60	20·5	1,425	2·94	41·94	W. K. Barnes	Tipperary Kitty's Commander (5332)
Crantock Fancy Times	Jersey	....	24–8–43	27–2–46	30	16	480	4·11	19·83	Mrs. G. H. Burnside	Werribe David (18183)
Horsford Camelia 12th	A.I.S.	....	22–4–44	14–5–46	30	20·5	615	3·21	19·77	W. K. Barnes	Wooroloo Red Lad (5418)

COWS 2½ YEARS AND UNDER 3 YEARS—STANDARD 250LB. BUTTER-FAT.

Koojan Ace's Gladsome	Guernsey	....	24–3–43	29–9–45	273	34	8,982	5·01	450·72	A. W. Padbury	Homestead Ace (Imp.) (1631)
Grass Vale Lady Fowler 56th	Jersey	..	28–5–42	20–5–45	273	21	7,788	5·72	445·41	R. H Rose & Son	Grass Vale Gold Boy (14684)
Koojan Ideal's Noblemarks' Bo-Peep	Guernsey	....	1.–12–42	31–8–45	273	30	8,610	5·02	432·31	A. W. Padbury ...	Koojan Ideal's Noblemark (5949)
Westlawn Gentle	A.I.S	....	5–9–42	29–5–45	273	23	10,299	3·79	390·77	Mrs. E. L. Brockman	Glanavon Pilot (5747)
Lansdowne Ideal's Joybell	Guernsey	....	21–11–42	15–6–45	273	22	7,206	5·22	361·95	J. R. Giles	Koojan Beau Ideal (4965)
Koojan Ace's Diahtnus	do.	10687	29–6–42	27–3–45	273	21	6,183	5·55	343·69	A. W. Padbury	Homestead Ace (Imp.) (1631)
Wooroloo Deana	A.I.S.	....	16–12–42	8–9–45	273	20	7.620	4·37	333·47	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Wooroloo Wynette	do.	41212	2–4–42	12–3–45	273	13	7,539	4·24	319·77	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Travalgon Starbright 19th....	Jersey	....	7–6–42	23–5–45	273	13	5.844	5·34	312·33	W. H. & T. F. Robinson	Orphanage Douglas (18919)
Denmark Reflectionette	Guernsey	....	15–11–42	6–6–45	273	15	6,225	4·86	303·13	Denmark Research Station	Koojan Ideal's Reflcetion (4974)
Claremont Belle 5th	A.I.S.	....	26–11–42	10–6–45	273	26	7,758	3·90	302·70	Claremont Hospital for Insane	Westby Masterpiece (5403)
Wooroloo Gwen 2nd	do.	41185	1–2–42	2–1–45	273	20	6,970	4·24	296·13	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Lansdowne Ideal's Dainty	Guernsey	....	22–2–43	7–9–45	273	23·5	6,100	4·83	294·67	J. R. Giles	Koojan Beau Ideal (4965)

TABLE 9—HERD TESTING—continued.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight of Milk on Last Day of Test. lb.	Weight of Milk for Period. lb.	Average Test. %	Weight of Butter-Fat for Period. lb.	Owner.	Sire.
COWS 2½ YEARS AND UNDER 3 YEARS—STANDARD 250 LB BUTTER-FAT—*continued.*											
Wattle Creek Rivette	A.I.S.	....	23-9-42	13-9-45	273	12	7,326	3·98	291·62	E. T. Thatcher	Wattle Creek Duchess's Monarch (5399)
Kapara Sparkle's Lassie	Jersey	....	14-10-42	12-6-45	273	15	6,000	4·82	289·72	D. Bradford	Congelin Jolly Eminent 3rd (18425)
Crantock Fancy Socks	do.	....	15-7-42	9-6-45	273	11	5,898	4·99	284·27	Mrs. G. H. Burnside	Werribee David (18183)
Wooroloo Greta	A.I.S.	....	20-12-42	15-7-45	273	18	6,384	4·41	282·10	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Colmyn Express	Jersey	....	9-9-42	12-7-45	240	5	5,175	5·28	273·48	Mrs. C. H. Ironmonger	Greenmount Cream Lad (18577)
Wooroloo Lady May 4th	A.I.S.	....	13-2-43	31-8-45	273	16	5,898	4·58	270·25	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Wooroloo Lady May 2nd	do.	41195	2-3-42	26-12-44	273	23	6,069	4·43	268·92	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Wooroloo Red Lady	do.	41203	6-3-42	25-12-44	273	16	6,138	4·33	266·07	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Travalgon Lady Eion 15th	Jersey	....	25-7-42	17-6-45	273	11	4,743	5·41	256·88	W. H. & F. T. Robinson	Orphanage Douglas (18919)
Claremont Treasure 36th	A.I.S.	....	10-12-42	19-6-45	273	20	6,420	3·94	252·49	Claremont Hospital for Insane	Summerlea Churchill (6236)
Claremont Hilda 14th	do.	....	20-10-42	1-5-45	273	19	6,087	4·11	250·34	Claremont Hospital for Insane	Westby Monarch (5404)
Wooroloo Rene 2nd	do.	....	1-3-42	26-12-44	273	18	5,814	4·27	248·42	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Glenavon Rene 2nd	do.	....	16-10-42	18-5-45	273	22	6,111	4·02	246·19	D. Bevan & Sons	Glanavon Federal (6869)
Travalgon Lady Eion 16th	Jersey	....	3-9-42	9-6-45	273	12	4,446	5·51	245·29	W. H. & T. F Robinson	Glen Iris Golden Oxford (12694)
Wooroloo Jessie	A.I.S.	41191	4-3-42	17-12-44	273	14	5,592	4·22	236·51	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Wooroloo Doreen 5th	do.	41176	22-3-42	22-3-45	240	15	5,310	4·35	231·36	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Brookfied's Morden Lady 6th	Guernsey	10072	24-5-42	24-5-45	273	6·5	3,784	5·67	214·78	P. G. Hampshire & Son	Yarraview Clarinet 2nd (4629)
Kaparal Duchess	Jersey	....	14-9-42	2-7-45	273	2	3,756	5·58	209·77	D. Bradford	Congelin Mandarin (14542)
Narrogin Sally	A.I.S.	....	26-4-42	18-4-45	240	11	4,890	4·22	206·30	Narrogin School of Agriculture	Tipperary Amy's Mascot (6338)
Wattle Creek Vida	do.	....	9-8-42	1-8-45	210	7	5,630	3·65	205·86	E. T. Thatcher	Wattle Creek Duchess's Monarch (5399)
Wattle Creek Bertha	do.	....	5-12-42	8-10-45	210	7	4,980	3·99	199·02	E. T. Thatcher	Wooroloo Royal Standard (6414)
Narrogin Doreen	do.	....	13-8-42	17-4-45	273	9·5	5,233	3·71	194·13	Narrogin School of Agriculture	Tipperary Amy's Mascot (6338)
Radyr Park Dorothy 19th	Jersey	....	16-3-42	12-12-44	240	12·5	4,110	4·63	190·65	L. M. Temple	Navua Coronation Star (14929)
Claremont Biddy 71st	do.	....	18-12-42	4-9-45	240	12	4,770	3·62	173·10	W. K. Barnes	Westby Monarch (5404)
Travalgon Lady Eion 14th	Jersey	....	11-6-42	24-5-45	273	6	2,838	5·54	157·36	W. H. & T. F. Robinson	Travalgon Oxford's King (19160)
Narrogin Dainty	A.I.S.	....	2-5-42	24-4-45	180	6	2,925	5·27	151·86	Narrogin School of Agriculture	Westby Masterpiece (5403)

Radyr Park Dorothy 21st	Jersey	....	23-3-43	13-12-45	180	9·5	2,825	4·72	133·56	L. M. Temple	Navua September Lad (14023)
Plenarbor Hetty	A.I.S.	....	6-1-43	23-11-45	210	6	2,925	4·53	132·57	Mrs. V. Alexander	Glanavon Genius (3957)
Muresk Dame Enid	Guernsey	....	17-5-42	19-2-45	273	7	2,391	5·13	122·85	Muresk Agricultural College	Muresk Arthur (4338)
Glanavon Dahlia 18th	A.I.S.	....	8-2-43	5-10-45	180	7	2,667	4·19	111·81	D. Bevan & Sons	Blackland's Monarch's Commander (1877)
Juadine Nancy 2nd	Jersey	....	26-9-42	3-9-45	60	21	1,350	8·13	109·86	B. Langridge	Austral Park Wonderful Standard (12423)
Denmark Golden Velvet	Guernsey	....	1-6-43	13-12-45	150	11·5	2.355	4·35	102·57	Denmark Research Station	Koojan Ideal's Reflection (4974)
Glanavon Gold 5th	A.I.S.	....	10-3-42	16-2-45	150	12	2,475	3·98	98·58	D. Bevan & Sons	Newstead Triumph (3420)
Glanavon Gold 6th	do.	....	6-1-43	22-8-45	60	33	2,040	3·79	77·49	D. Bevan & Sons	Newstead Triumph (3420)
Grass Vale Buttercup 11th	Jersey	....	5-7-42	8-4-45	30	40	1,200	5·20	62·46	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Grassvale Lady Fowler 38th	Jersey	....	1-9-42	20-6-45	30	26	780	4·87	38·04	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Muresk Mayfus	Guernsey	....	9-1-43	11-8-45	60	9	660	4·36	28·83	Muresk Agricultural College	Koojan Ideal's Dictator (4167)
COWS 3 YEARS AND UNDER 3½ YEARS.—STANDARD 270 LB. BUTTER-FAT.											
Grassvale Northwood Eve	Jersey	....	3-7-42	2-9-45	273	27	11.511	5·69	655·15	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Juadine Peerless Lily 20th	do.	....	10-12-41	4-5-45	273	27	8,976	6·10	547·67	Miss L. G. Hancock	Austral Park Wonderful Standard (14243)
Grassvale Lady Fowler 35th	do.	....	1-3-42	23-6-45	273	14	7,182	5·97	428·86	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Kapara Happy Days	do.	....	3-12-41	19-5-45	273	17	63,51	5·55	353·09	D. Bradford	Grantham Easter Oxford (14677)
Denmak Mary's Bonnie ...	Guernsey	10295	22-7-41	26-12-44	273	22	6,426	5·38	345·83	Denmark Research Station	Denmark Lady's Goldseeker (4799)
Juadine Peerless Lily 21st	Jersey	....	5-9-42	3-12-45	180	19	4,875	6·69	326·43	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Denmark Dame 2nd	Guernsey	10289	6-11-41	22-12-44	273	18	5,844	5·56	325·02	Denmark Research Station	Denmark Lady's Goldseeker (4799)
Kapara Velveteen	Jersey	....	23-5-42	15-6-45	273	8	6,204	5·03	312·34	D. Bradford	Congelin Mandarin (14542)
Eungella Miss Muffet	do.	....	5-5-42	20-6-45	273	14·5	5.488	5·41	297·03	D. G. Spark	Travalgon Starbright King (18129)
Norinya Nita	do.	....	3-9-41	11-12-44	273	11·5	5,179	5·55	287·75	Mrs. A. G. Eckersley	Navua Royal Star (15869)
Wattle Creek Buttercup	A.I.S.	....	5-1-42	13-7-45	240	4	7,200	3·95	284·64	E. T. Thatcher	Wooroloo Royal Standard (6414)
Radyr Park Dorothy 20th	Jersey	....	17-6-42	15-7-45	273	6	5.748	4·85	279·24	L. M. Temple	Navua September Lad (14023)
Kapara Dairymaid	do.	....	24-6-42	12-7-45	273	6	5,508	5·03	277·08	D. Bradford	Congelin Mandarin (14542)
Woorloo Vanity	A.I.S.	41211	12-8-41	26-12-44	273	14	6,402	4·56	275·96	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Wattle Creek Marjorie	do.	....	30-7-41	23-10-44	273	15	6,135	4·28	262·62	E. T. Thatcher	Wattle Creek Duchess's Monarch (5399)
Norinya Nada	Jersey	....	10-11-41	4-12-44	273	12	5,181	4·99	259·00	Mrs. A. G. Eckersley	Navua Royal Star (15869)
Wattle Creek Ruby	A.I.S.	....	1-11-41	1.-7-45	240	6	5,790	4·22	248·43	E. T. Thatcher	Wooroloo Royal Standard (6414)
Glenavon Dahlia 15th	do.	....	30-4-42	31-7-45	273	7	5,811	4·23	245·91	D. Bevan & Sons	Blackland's Monarchs Commander (1877)
Carbunup Esther	do.	....	18-2-42	26-5-45	273	3	6.099	4·01	244·61	D.H. Bell	Glanavon Maestro (4833)
Muresk Delanthia	Guernsey	....	2-6-42	16-9-45	273	18	5,694	4·28	244·25	Muresk Agricultural College	Muresk Arthur (4338)
Korigekup Lady Morn	Jersey	....	24-4-42	22-5-45	273	7	4,176	5·74	239·99	Mrs. A. G. Eckersley	Mornmoot Northwood Beau (17798)
Travalgan Starbright 18th	do.	....	2-6-42	18-6-45	273	11	4,278	5·51	235·91	W. H. & T. F. Robinson	Orphanage Douglas (18919)
Narrogin Milly	A.I.S.	....	5-5-42	14-5-45	273	15	6,780	3·42	232·24	Narrogin School of Agriculture	Tipperary Amy's Mascot (6338)
Glenavon Melba 5th	do.	....	16-4-42	11-8-45	273	12	5,796	3·95	229·64	D. Bevan & Sons	Newstead Triumph (3420)

TABLE 9—HERD TESTING—continued.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight of Milk Last Day of Test. lb.	Weight of Milk for Period. lb.	Average Test. %	Weight of Butter Fat for Period. lb.	Owner.	Sire.
COWS 3 YEARS AND UNDER 3½ YEARS—STANDARD 270 LB BUTTER-FAT.—*continued.*											
Camden Pit-a-Pat	Jersey	....	15–1–42	26–1–45	240	15	3,900	5·85	228·30	B. Langridge	Greenmount Golden Sultan (14688)
Clovelly Lily	Guernsey	10244	25–8–42	6–9–45	240	7	3,990	5·67	226·59	Mrs. L. R. Barnsby	Lansdowne Polydymite (4995)
Clovelly Kitty	do.	10243	20–6–42	5–7–45	273	9	4,647	4·84	225·25	Mrs. L. R. Barnsby	Lansdowne Polydymite (4995)
Colmyn Coral 2nd	Jersey	....	15–9–42	17–11–45	210	10	4,020	5·42	218·16	C. H. Ironmonger	Greenmount Cream Lad (18577)
Plenarbor Curley	A.I.S.	....	26–6–42	7–9–45	273	12	5,946	3·64	216·97	Mrs. B. Alexander	Glanavon Genius (3957)
Glenavon Pink Pearl 5th	do.	36573	16–8–41	10–11–44	273	9	5,307	3·91	207·91	D. Bevan & Son	Tipperary President (5335)
Muresk Marguerite	Guernsey	11068	3–2–42	20–5–45	273	9	3,477	5·92	206·16	Muresk Agricultural College	Muresk Arthur (4338)
Wattle Creek Scarlet	A.I.S.	....	16–8–42	23–9–45	240	11	5,040	4·07	205·14	E. T. Thatcher	Wattle Creek Duchess's Monarch (5399)
Plenarbor Saphire	do.	....	5–3–42	30–7–45	240	5·5	5,175	3·95	204·84	Mrs. V. Alexander	Glanavon Genius (3957)
Glanavon Daphne 8th	do.	....	14–4–42	24–8–45	240	7	5,070	3·99	202·32	D. Bevan & Sons	Newstead Triumph (3420)
Rosella Jeanette	Guernsey	....	2–4–42	31–7–45	240	1·5	3,225	5·77	186·21	Darnell Bros.	Muresk Commander (9599)
Glanavon Golden Girl 7th	A.I.S.	....	5–8–42	9–9–45	210	8	4,290	4·26	182·79	D. Bevan & Sons	Newstead Triumph (3420)
Wattle Creek Stella	do.	....	22–9–43	9–10–45	210	8	4,470	4·02	180·12	E. T. Thatcher	Wattle Creek Duchess's Monarch (5399)
Muresk Vanity Fair	Guernsey	11075	20–4–42	25–7–45	240	10	3,300	5·39	178·14	Muresk Agricultural College	Muresk Arthur (4338)
Plenarbor Primrose	A.I.S.	....	28–6–42	22–9–45	240	6	4,620	3·85	177·87	Mrs. V. Alexander	Glanavon Genius (3957)
Wooroloo Dasher	do.	41174	23–2–42	27–4–45	210	5	3,930	4·51	177·39	Wooroloo Sanatorium Farm	Wooroloo Red Baron (6412)
Glanavon Golden Girl 6th	do.	36555	17–9–41	12–2–45	210	12	4,290	3·98	171·03	D. Bevan & Sons	Newstead Triumph (3420)
Wooroloo Sun Lady 4th	do.	41210	15–3–42	2–4–45	240	9	3,720	4·28	159·35	Wooroloo Sanatorium Farm	Berry Rufus 2nd (6570)
Glanavon Buttercup 7th	do.	....	17–3–42	3–9–45	180	12	3,930	3·89	153·21	D. Bevan & Sons	Blacklands Monarch's Commander (1877)
Glanavon Charmer 2nd	do.	....	22–12–41	21–1–45	240	10	3,720	4·10	152·85	D. Bevan & Sons	Blacklands Monarch's Commander (1877)
Koojan Ace's Bluebird	Guernsey	10686	9–6–42	30–9–45	180	7	3,000	4·66	139·95	Darnell Bros.	Homestead Ace (Imp.) (1631)
Muresk Rosenthall	do.	....	2–5–42	7–8–45	210	9	2,490	5·03	125·34	Muresk Agricultural College	Muresk Arthur (4338)
Mereworth Vanilla Queen 4th	Jersey	....	30–6–42	13–8–45	90	28	2,625	4·55	119·58	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)
Denmark Jonquil 2nd	Guernsey	10294	19–7–42	30–12–45	120	8	1,725	4·54	78·36	Denmark Research Station	Denmark Rosette's Dictator (4804)
Tipperary Lovely 6th	A.I.S.	....	14–9–42	21–12–45	30	3	990	3·65	36·18	W. G. Burges	Tipperary Ace (6336)
COWS 3½ YEARS AND UNDER 4 YEARS—STANDARD 290 LB. BUTTER-FAT.											
Juadine Peerless Lily 19th	Jersey	....	26–10–41	20–5–45	273	23	8,039	6·27	503·05	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Grass Vale Golden Cream 25th	do.	....	7–5–41	5–5–45	273	15	7,425	6·12	455·14	R. H. Rose & Son	Grassvale Gold Boy (14684)
Grass Vale Lady Fowler 33rd	do.	....	7–7–41	6–5–45	273	20	8,220	5·51	453·06	R. H. Rose & Son	Mornmoot Northward Beau (17798)

Grass Vale Northwood Nora	do.	86646	23–5–41	8–3–45	273	19	6,627	6·37	422·72	R. H. Rose & Son	Mornmoot Northward Beau (17798)
Tipperary Lovely 5th	A.I.S.	40645	10–6–41	6–6–45	273	17	9,321	4·34	405·33	W. G. Burges	Tipperary Ace (6336)
Grass Vale Nora's Maid	Jersey	....	9–9–41	8–7–45	273	13	7,929	5·07	402·57	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Grass Vale Magnolia 3rd	do.	....	13–8–41	21–4–45	273	14	6,042	6·00	362·93	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Crantock Master Princess	do.	....	28–7–41	12–6–45	273	11	7,383	4·84	357·51	Mrs. G. H. Burnside	Werribee David (18183)
Mayvale Discoverer's Bluebell	Guernsey	10865	19–10–41	20–7–45	273	13	5,589	5·92	331·35	R. J. Giles	Koojan Ideal's Discoverer (4968)
Carbunup Dahlia	A.I.S.	35386	22–3–41	19–3–45	273	24	8,682	3·78	328·31	D. H. Bell	Glanavon Maestro (4833)
Wooregong Beauty	do.	....	20–6–41	6–5–45	273	10	7,590	4·27	324·45	W. G. Burges	Melrose Sunny Boy (4185)
Eungella Dark Venus	Jersey	....	18–5–41	14–4–45	273	21	6,378	5·05	322·38	D. G. Spark	Travalgon Starbright King (18129)
Narrogin Dolly	A.I.S.	38669	28–8–41	1–4–45	273	21	7,698	4·07	313·69	Narrogin School of Agriculture	Westby Masterpiece (5403)
Radyr Park Dorothy 19th	Jersey	....	16–3–42	13–10–45	273	17·5	7,282	4·26	310·37	L. M. Temple	Navua Coronation Star (14929)
Clovelly Crystal	Guernsey	10240	31–8–41	30–7–45	273	4·5	6,568	4·65	305·66	Mrs. L. R. Barnsby	Koojan Monogram (4174)
Carbanup Doris	A.I.S.	35389	3–8–41	31–7–45	240	2	8,355	3·63	303·87	D. H. Bell	Glanavon Maestro (4833)
Glanavon Rita 4th	do.	....	25–12–41	19–8–45	273	18	6,284	4·72	296·76	D. Bevan & Sons	Glanavon Guthrie (5743)
Westlawn Patricia	do.	....	12–6–41	6–6–45	273	4	7,557	3·88	293·52	Messrs. E. L. Brockman	Valliere Patrico (5363)
Denmark Ace's Rose	Guernsey	10284	29–11–41	31–8–45	273	18	6,324	4·61	287·94	Denmark Research Station	Homestead Ace (Imp.) (1631)
Brookfield's Queen 10th	do.	10078	19–11–41	18–10–45	273	12	5,901	4·62	272·84	P. G. Hampshire & Son	Yarraview Clarionette (4628)
Narrogin Colleen	A.I.S.	38665	22–8–41	22–3–45	273	12·5	6,922	3·91	270·56	Narrogin School of Agriculture	Westby Masterpiece (5403)
Radyr Park Dorothy 14th	Jersey	....	22–4–41	1–1–45	273	16	5,673	4·67	265·18	L. M. Temple	Navua September Lad (14023)
Tipperary Maggie 8th	A.I.S.	40648	1–9–41	7–8–45	210	15	6,270	4·06	255·18	W. G. Burgess	Liberton Venturer (4988)
Radyr Park Clarionette 5th	Jersey	88641	17–7–41	9–6–45	273	10	5,010	5·09	255·16	L. M. Temple	Navua September Lad (14023)
Brookfield's Prunella	Guernsey	10075	19–12–40	12–12–44	240	12	5,010	4·91	246·30	P. G. Hampshire & Son	Brookfield's Baron (3936)
Wooroloo Ethel	A.I.S.	41179	2–4–41	26–12–44	273	5	5,685	4·17	237·41	Wooroloo Sanatorium Farm	Wooroloo Red Lad (5418)
Radyr Park Dorothy 16th	Jersey	88643	4–6–41	6–3–45	273	5	4,350	5·36	233·42	L. M. Temple	Navua Coronation Star (1429)
Muresk Dultana	Guernsey	11060	22–3–41	16–10–44	273	8	4,689	4·93	321·40	Muresk Agricultural College	Denmark Damon (2519)
Muresk Danzig	do.	11062	15–1–42	15–10–45	240	16	4,260	5·12	218·28	Muresk Agricultural College	Muresk Arthur (4338)
Muresk Diamond Lass	do.	11064	28–10–41	10–5–45	273	9	3,897	5·56	217·03	Muresk Agricultural College	Denmark Damon (2519)
Glanavon Penelope 3rd	A.I.S.	36569	4–4–41	16–11–44	273	10	5,610	3·85	217·29	D. Bevan & Sons	Blackland's Jean's Supreme (1871)
Wooroloo Lady Fair 5th	A.I.S.	41193	9–5–41	1–3–45	273	7	4,671	4·49	209·95	Wooroloo Sanatorium Farm	Wooroloo Triumph's Heir (4493)
Yanget Grace	do.	....	3–9–41	25–6–45	273	9	5,892	3·54	209·10	Mrs. V. Alexander	Yanget Baron
Rosella Girlie	Guernsey	....	15–2–42	15–9–45	210	3·5	4,065	4·99	202·98	Darnell Bros.	Muresk Commander
Planarbor Valli	A.I.S.	....	15–2–42	2–9–45	210	9	4,410	3·98	175·65	Mrs. V. Alexander	Glanavon Genius (3957)
Tipperary Dove 19th	do.	40639	9–10–41	26–8–45	150	13	3,720	4·31	160·68	W. B. Burges	Liberton Venturer (4988)
Wooroloo Bella	do.	41168	26–4–41	9–12–44	240	5	3,660	4·36	159·75	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Glanavon Doris 12th	do.	36540	17–2–41	21–11–44	210	7	3,540	4·05	143·40	D. Bevan & Sons	Tipperary President (5335)
Brookfield's Faith 9th	Guernsey	10067	28–9–41	29–9–45	60	22·5	1,350	4·43	59·88	P. G. Hampshire & Son	Yarraview Clarinet 2nd (4629)
COWS 4 YEARS AND UNDER 4½ YEARS—STANDARD 310 LB. BUTTER-FAT.											
Koojan Ideal's Judith	Guernsey	10696	24–6–40	19–12–44	273	15	8,145	5·34	435·68	A. W. Padbury	Glenburnie Ideal (Imp.) (2548)
Grass Vale Lady Fowler 32nd	Jersey	86644	11–6–41	5–8–45	273	16	8,178	5·31	434·71	R. H. Rose & Son	Mornmoot Northwood Beau (17798)
Carbanup Dora	A.I.S.	35388	1–4–41	25–6–45	273	9·5	11,531	3·72	429·61	D. H. Bell	Glanavon Maestro (4833)
Congelin Sparkle 4th	Jersey	....	15–3–41	27–6–45	273	15·5	8,131	4·46	363·18	D. Bradford	Congelin Washington (18426)
Lansdowne Jocelyn	Guernsey	....	15–7–40	4–11–44	240	16·5	6,675	5·17	345·24	A. W. Padbury	Koojan Beau Ideal (4965)

TABLE 9—HERD TESTING—continued.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight of Milk Last Day of Test. lb.	Weight of Milk for Period. lb.	Average Test. %	Weight of Butter Fat for Period. lb.	Owner.	Sire.
COWS 4 YEARS AND UNDER 4½ YEARS—STANDARD 310 LB BUTTER-FAT.—*continued.*											
Crantock Starbright Sunset	Jersey	85803	2-4-41	26-5-45	273	12	6,456	5·34	345·02	Mrs. G. H. Burnside	Crantock Starbright's Airman (15491)
Kapara Rosebud	do.	....	8-6-41	7-8-45	273	6	7,053	4·85	342·52	D. Bradford	Congelin Mandarin (14542)
Congelin Iolanthe 11th	do.	....	21-3-41	12-7-45	273	4·5	4,633	5·17	339·84	D. Bradford	Congelin Washington (18426)
Radyr Park June 2nd	do.	88645	16-5-41	12-7-45	273	15·5	6,841	4·85	332·17	L. M. Temple	Navua Coronation Star (14929)
Eungella Bonetta	do.	....	17-5-41	5-7-45	273	13	5,919	5·22	309·00	D. G. Spark	Travalgon Starbright King (18129)
Muresk Lady Boniface	Guernsey	11067	23-4-41	17-8-45	273	8	5,814	5·22	303·97	Muresk Agricultural College	Denmark Damon (2519)
Congelin Happy Days 3rd....	Jersey	85704	1-2-41	14-7-45	240	11	6,660	4·51	300·81	D. Bradford	Congelin Washington (18426)
Glanavon Spangle 2nd	A.I.S.	....	25-7-41	18-8-45	273	13	6,639	4·30	285·72	D. Bevan & Sons	Blacklands Monarch's Commander (1877)
Lansdowne Bonny Jean 2nd	Guernsey	10707	12-6-41	22-10-45	273	10·5	4,941	5·52	273·06	P. G. Hampshire & Son	Koojan Beau Ideal (4965)
Glanavon Doris 13th	A.I.S.	36541	25-2-41	31-3-45	273	18	6,564	4·12	271·02	D. Bevan & Sons	Blacklands Monarch's Commander (1877)
Glanavon Ettie 2nd	do.	36545	17-10-40	24-12-44	273	13	6,039	4·24	256·08	D. Bevan & Sons	Glanavon Gold's Final (5742)
Narrogin Daisybell	do.	38668	10-10-40	17-3-45	273	5·5	6,091	4·19	255·74	Narrogin School of Agriculture	Westby Masterpiece (5403)
Clovelly Wavelet	Guernsey	10247	28-5-41	9-9-45	180	9	5,010	4·53	227·01	Mrs. L. R. Barnsby....	Koojan Monogram (4174)
Radyr Park Dorothy 15th	Jersey	88642	26-4-41	25-6-45	240	5	4,395	4·76	209·49	L. M. Temple	Navua Coronation Star (14929)
Glanavon Buttercup 4th	A.I.S.	36529	12-10-40	28-12-44	240	9	4,080	4·16	170·04	D. Bevan & Sons	Parkview Commodor (306)
Wooroloo Sun Lady 3rd	do.	41209	16-2-41	4-4-45	150	7	3,120	4·36	136·05	Wooroloo Sanatorium Farm	Wooroloo Red Lad (5418)
Plenarbor Duchess	do.	39211	12-9-40	14-2-45	150	8	1,785	4·21	75·15	Mrs. V. Alexander	Wooroloo Triumph's Heir (4493)
COWS 4½ YEARS AND UNDER 5 YEARS—STANDARD 330 LB. BUTTER-FAT.											
Juadine Queen	Jersey	87022	20-5-40	1-2-45	273	29·5	8,968	6·37	571·69	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Grass Vale Lady Fowler 31st	do.	81634	17-8-40	6-5-45	273	23	9,069	5·31	481·94	R. H. Rose & Son	Grass Vale Gold Boy (12684)
Koojan Golden Jewel	Guernsey	8805	12-3-40	21-1-45	273	18	7,134	6·07	433·22	A. W. Padbury	Koojan Beau Ideal (4965)
Congelin Velveteen 2nd	Jersey	80831	19-7-40	11-6-45	273	14·5	9,193	4·70	432·57	D. Bradford	Rosecliff Marchalong (15094)
Tipperary Beauty 9th	A.I.S.	40631	21-2-40	11-1-45	273	22	9,246	4·32	399·86	W. G. Burges	Blacklands Monarch's Commander (1877)
Colmyn Golden Mayflower....	Jersey	80803	20-8-40	9-6-45	273	10	8,370	4·67	391·09	C. H. Ironmonger	Clarendon Eyre Golden Oxford (13606)
Tipperary Beauty 13th	A.I.S.	40634	23-1-41	28-9-45	273	18	8,604	4·27	367·88	M. H. Montgomery	Blacklands Monarch's Commander (1877)
Kapara Sparkle's Lassie	Jersey	82173	22-8-40	27-5-45	273	12·5	6,832	5·14	351·54	D. Bradford	Congelin V.C. (16412)
Wooroloo Pigeon	A.I.S.	41198	20-9-40	16-6-45	273	19	7,962	4·32	343·99	Wooroloo Sanatorium Farm	Wooroloo Triumph's Heir (4493)

Wooroloo Netta 3rd	do.	41197	6-12-40	15-9-45	273		7,614	4·46	340·14	Wooroloo Sanatorium Farm	Wooroloo Red Lad (5418)
Colmyn Golden Joy Bells	Jersey	80799	11-6-40	14-5-45	273	12·5	6,262	5·28	330·71	C. H. Ironmonger	Clarendon Eyre Golden Oxford (13606)
Narrogin Stella	A.I.S.	38676	19-4-40	13-3-45	273	7·5	6,907	4·15	286·81	Narrogin School of Agriculture	Westby Masterpiece (5403)
Wooroloo Lilac 2nd	do.	....	18-12-39	19-10-44	273	7	6,111	4·39	268·65	Wooroloo Sanatorium Farm	Wooroloo Triumph's Heir (4493)
Colmyn Golden Lustre	Jersey	....	5-9-40	5-7-45	273	11	5,253	5·06	266·01	C. H. Ironmonger	Clarendon Eyre Golden Oxford (13606)
Wooroloo Jeanette 4th	A.I.S.	41190	19-9-40	4-9-45	273	9	6,042	4·37	264·12	Wooroloo Sanatorium Farm	Wooroloo Red Lad (5418)
Eungella Coquette	Jersey	81271	24-5-40	13-4-45	273	16	4,878	5·27	257·12	D. G. Spark	Greenmount Golden Sovereign (14687)
Mayvale Rosy Aster	Guernsey	10870	27-9-40	11-7-45	240	14	4,800	5·31	255·00	R. J. Giles	Denmark Rosy Outlook (4017)
Rosella Zinnia	do.	11430	11-8-40	10-6-45	240	7	5,670	4·32	245·28	Darnell Bros.	Muresk Paul (4356)
Clovelly Tigress	do.	10246	11-7-40	11-5-45	273	7	4,731	5·13	243·13	Mrs. L. R. Barnsby	Koojan Monogram (4174)
Wooroloo Cherry	A.I.S.	41171	28-7-40	23-4-45	210	7	5,400	4·37	236·16	Wooroloo Sanatorium Farm	Wooroloo Red Lad (5418)
Wooroloo Purple	do.	41201	2-10-40	8-5-45	273	5	5,445	4·32	235·66	Wooroloo Sanatorium Farm	Wooroloo Red Lad (5418)
Narrogin Clara	do.	38664	19-3-40	27-2-45	273	18	6,099	3·43	209·61	Narrogin School of Agriculture	Westby Masterpiece (5403)
Glanavon Melba 3rd	do.	36566	11-11-40	28-7-45	210	11	4,800	3·97	190·89	D. Bevan & Sons	Blackland's Jean's Supreme (1871)
Mereworth Oxford Fondant	Jersey	....	11-5-40	14-5-45	180	17	3,975	4·38	174·54	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)
Narrogin Mollie	A.I.S.	38672	22-4-40	5-4-45	273	13	4,509	3·41	153·92	Narrogin School of Agriculture	Westby Masterpiece (5403)
Mereworth Starbright Queen 4th	Jersey	87806	23-6-40	26-5-45	150	14	2,760	4·68	129·30	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)
Koojan Ace's Thelma	Guernsey	10690	30-5-42	25-6-45	90	17	2,010	5·55	111·75	A. W. Padbury	Homestead Ace (Imp.) (1631)
COWS 5 YEARS OLD AND OVER STANDARD 350 LB. BUTTER-FAT.											
Juadine Peerless Lily 13th	Jersey	76977	20-12-38	25-8-45	273	28·5	10,510	6·48	681·73	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Camden Circe	do.	80637	24-9-39	9-10-44	273	18	9,234	6·93	640·20	C. E. Kruger	Greenmount Golden Sultan (14688)
Congelin Rose Marie 6th	do.	80830	14-4-40	9-6-45	273	14	9,267	6·20	575·07	D. Bradford	Rosecliffe Marchalong (15094)
Wooroloo Rosebud 3rd	A.I.S.	33999	29-5-39	17-5-45	273	26·5	12,184	4·41	537·37	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Congelin Iolanthe 8th	Jersey	80828	22-4-40	9-5-45	273	26	10,113	5·28	534·72	D. Bradford	Rosecliffe Marchalong (15094)
Juadine March Flower	do.	81988	5-3-39	21-10-45	210	29	8,820	5·57	492·06	Miss L. G. Hancock	Austral Park Wonderful Standard (12423)
Denmark Petal	Guernsey	6968	4-10-37	31-8-45	273	13·5	8,110	5·45	442·72	Denmark Research Station	Koojan Golden Prosper (2283)
Eungella Bright Lass	Jersey	76185	5-8-38	9-7-45	273	19	8,967	4·91	440·54	D. G. Spark	Greenmount Bright Lad (15640)
Wooroloo Heather	A.I.S.	23247	5-11-37	4-9-45	273	6	10,173	4·32	439·57	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Carbanup Beatrice	do.	29617	13-3-39	24-2-45	273	32·5	11,812	3·69	436·62	D. H. Bell	Glanavon Maestro (4833)
Glanavon Dahlia 7th	do.	30581	23-3-38	23-8-45	273	20	10,290	4·14	427·01	D. Bevan & Sons	Glanavon Neptune (3959)
Coogely Jonquil	Guernsey	6945	1-11-37	18-8-45	273	22	7,056	6·03	425·72	Denmark Research Station	Coogelly Judy's Goldmine (2621)

TABLE 9—HERD TESTING—continued.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight of Milk Last Day of Test. lb.	Weight of Milk for Period. lb.	Average Test. %	Weight of Butter Fat for Period. lb.	Owner.	Sire.
COWS 5 YEARS AND OVER—STANDARD 350 LB BUTTER-FAT—*continued.*											
Claremont Fancy 9th	A.I.S.	....	30-6-40	30-7-45	27	34	10,992	3·80	417·73	Claremont Hospital for Insane	Wooroloo Tiumph 4th (3627)
Kapara Sparkle 3rd	Jersey	77064	21-7-39	6-6-45	273	17	7,971	5·11	407·57	D. Bradford	Congelin Mandarin (14542)
Koojan Ace's Dulcie	Guernsey	5658	6-3-36	12-1-45	273	21	7,563	5·37	406·77	Denmark Research Station	Homestead Ace (Imp.) (1631)
Radyr Park Dorothy 10th	Jersey	83556	4-7-39	15-6-45	273	20	8,850	4·58	406·09	L. M. Temple	Navua Coronation Star (14929)
Carbanup Baroness	A.I.S.	29616	15-4-39	12-3-45	273	28	12,264	3·28	402·85	D. H. Bell	Glanavon Maestro (4833)
Wooroloo Faith	do.	33989	10-1-39	27-10-44	273	14	8,772	4·58	402·22	Wooroloo Sanatorium Farm	Glanavon Genius (3957)
Greenmount Bonetienne's Twinkle	Jersey	44201	24-3-33	3-6-45	273	15·5	7,156	5·60	400·73	D. G. Spark	Bellefaire Bonaparte's Bonetienne (9224)
Denmark Golden Glory	Guernsey	6965	13-5-38	30-4-45	273	14·5	6,703	5·97	400·59	Denmark Research Station	Denmark Damon (2519)
Denmark Diamond	do.	6963	28-6-36	6-11-44	273	15	6,975	5·62	392·39	Denmark Research Station	Denmark Damon (2519)
Tipperary Beauty 7th	A.I.S.	33565	29-7-39	24-12-44	273	26	8,598	4·54	390·71	W. G. Burges	Wooroloo Melba's Triumph (4491)
Glanavon Aster	do.	30575	18-1-38	16-2-45	273	36	9.768	3·99	390·34	D. H. Bell	Glanavon Nimrod (437)
Crantock Silk Socks	Jersey	70901	6-6-37	12-4-45	273	18	6,609	5·74	379·80	Mrs. G. H. Burnside	Congelin Eminent's Golden (13623)
Carbanup Crocus	A.I.S.	35385	25-3-40	6-3-45	273	25	10,755	3·43	370·10	D. H. Bell	Glanavon Maestro (4833)
Denmark Dawn 2nd	Guernsey	5439	21-3-35	27-10-34	273	13	6,639	5·55	370·64	Denmark Research Station	Koojan Golden Prosper (2283)
Denmark Briar Rose	do.	6959	15-8-37	8-8-45	273	18·5	7,885	4·65	366·92	Denmark Research Station	Denmark Illustrious (3320)
Westlawn Fairy	A.I.S.	28530	4-11-36	5-7-45	273	6	9,783	3·72	364·66	Mrs. E. L. Brockman	Telyarup Roosevelt (1538)
Koojan Princess Juliana	Guernsey	8814	17-4-39	12-7-45	273	16	6,828	5·33	364·15	A. W. Padbury	Glenburnie Ideal (Imp.) (2548)
Greenmount Golden Gem	Jersey	76619	5-7-37	27-5-45	273	15·5	6,721	5·40	363·19	D. G. Spark	Bellefaire Bonaparte's Bonetienne (9224)
Westlawn Topsy	A.I.S.	33857	25-10-39	21-7-45	273	16·5	9,679	3·75	363·17	Mrs. E. L. Brockman	Beauna Vista Musket (3024)
Clovelly Rose	Guernsey	6931	1-10-36	26-4-45	273	20	7,290	4·95	360·93	Mrs. L. R. Barnsby	Muresk Achille's (1543)
Glanavon Pansy 5th	A.I.S.	36568	13-6-39	9-8-45	273	21	8,913	4·04	360·68	D. Bevan & Sons	Glanavon Franklin (4829)
Camden Patsy	Jersey	85543	27-6-39	10-2-45	273	13	5,619	6·38	358·93	C. E. Kruger	Greenmount Golden Sultan (14688)
Radyr Coronation Belle	do.	73600	5-7-38	21-7-45	273	13	7,389	4·81	356·06	L. M. Temple	Navua Coronation Star (14929)
Crantock Primula's Tulip	do.	70900	15-3-38	20-8-45	210	11	6,210	5·70	354·24	Mrs. G. H. Burnside	Congelin Eminent's Golden (13623)
Mayvale Discoverer's Anemone	Guernsey	10864	16-7-40	25-7-45	273	21	6,933	5·08	352·88	R. J. Giles	Koojan Ideal's Discoverer (4968)
Carbanup Constance	A.I.S.	35384	25-2-40	15-3-45	273	30	10,050	3·51	352·83	D. H. Bell	Glanavon Maestro (4833)
Denmark Bonnie Mary	Guernsey	6958	30-9-37	26-12-44	273	19	6,927	5·05	350·25	Denmark Research Station	Denmark Illustrious (3320)
Clovelly Golden Flirt	do.	8500	1-6-39	3-7-45	273	11	6,843	5·11	350·18	Mrs. L. R. Barnsby	Koojan Monogram (4174)
Wooroloo Sunlady 2nd	A.I.S.	....	25-3-40	2-9-45	273	20	7,290	4·80	350·16	Wooroloo Sanatorium Farm	Wooroloo Red Lad (5418)
Noorong Grace	Jersey	78124	3-10-33	19-5-45	273	7	6,366	5·44	346·80	C. E. Kruger	Grassvale Butter King (8209)

Denmark Golden Valencia 2nd	Guernsey	8535	15-9-39	22-2-45	273	10	6,210	5·57	346·35	Denmark Research Station	Koojan Ace's Goldseeker
Denmark Orange Bud	do.	4123	9-8-32	6-12-44	273	14	7.182	4·68	336·30	Denmark Research Station	Koojan Golden Prosper (22
Denmark Rosette	Guernsey	6972	21-7-36	26-10-44	273	12	6,126	5·47	335·11	Denmark Research Station	Koojan Golden Prosper (2283)
Camden Arachne	Jersey	80635	9-9-39	24-7-45	273	7·5	5,767	5·80	334·63	C. E. Kruger	Greenmount Golden Sultan (14688)
Camden Ariadne	Jersey	85538	10-8-40	3-9-45	120	40	5,820	5·74	334·75	C. E. Kruger	Greenmount Golden Sultan (14688)
Denmark Rosemary	Guernsey	5451	7-6-36	19-10-44	273	9·5	5,923	5·65	334·90	Denmark Reseacrh Station	Koojan Golden Prosper (2283)
Capel Starbright	A.I.S.	35381	15-7-40	26-8-45	273	16	9,108	3·64	332·02	M. H. Montgomery	Capel Star King (4672)
Clovelly Golden Pride	Guernsey	8501	26-10-38	23-5-45	273	11	7,083	4·66	330·17	Mrs. L. R. Barnsby	Drakesbrook Golden Gift (2651)
Colmyn Golden Melody	Jersey	75709	29-5-39	7-9-45	273	8	6,504	5·03	327·57	C. H. Ironmonger	Clarendon Eyre Golden Oxford (13606)
Wallatin Eighty Five	A.I.S.	40881	29-4-40	28-8-45	273	12	9,306	3·51	327·53	M. H. Montgomery	Summerlea Pioneer (6240)
Claremont Maggie Morrison 34th	do.	29757	13-5-39	15-8-45	240	12	8,010	4·04	323·64	Claremont Hospital for Insane	Claremont Ora'l Triumph (4689)
Colmyn Golden Carnartion	Jersey	....	30-7-40	11-9-45	273	7	6,696	4·79	320·78	C. H. Ironmonger	Clarendon Eyre Golden Oxford (13606)
Narinya Nanette	do.	....	9-6-39	10-12-44	273	16·5	6,579	4·85	319·55	Mrs. A. G. Eckersley	Austral Park Wonderful Standard (12423)
Muresk Sultana	Guernsey	7650	6-7-37	13-1-45	273	18	6,534	4·87	318·41	Muresk Agricultural College	Koojan Ace's Goldseeker (3431)
Denmark Mary Rose	do.	6966	7-7-38	23-8-45	273	11	6,093	5·22	318·39	Denmark Research Station	Denmark Auric (3313)
Wooroloo Glory	A.I.S.	28643	19-6-38	27-3-45	273	18	7,524	4·16	313·70	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Mereworth Butter Queen 4th	Jersey	82784	18-8-39	14-11-44	273	10	5,880	5·12	301·15	B. Langridge	Grantham Easter's Oxford (14677)
Muresk Delicia	Guernsey	9106	15-5-40	26-7-45	273	16	6,708	4·46	299·84	Muresk Agricultural College	Denmark Damon (2519)
Radyr Park Dorothy 5th	Jersey	68752	18-7-36	21-7-45	273	6·5	5,569	5·34	297·42	L. M. Temple	Greenmount Graceful Lad (7292)
Grantham Easter Rye 5th	do.	66773	8-7-37	26-12-44	273	16	5,403	5·43	293·50	B. Langridge	Greenmount Black Prince (6511)
Radyr Park Coronation's Estrellita	do.	83555	27-7-39	28-6-45	273	12	5,736	5·10	292·94	L. M. Temple	Navua Coronation Star (14929)
Denmark Dawn Childe	Guernsey	6962	14-5-37	27-11-44	273	12	5,196	5·57	289·38	Denmark Research Station	Wollongbar Reformer (538)
Crantock Starbright's Delphinium	Jersey	....	30-4-39	12-4-45	273	15	6,075	4·75	289·01	Mrs. G. H. Burnside	Congelin Eminen 's Golden (13623)
Denmark Golden Valencia	Guernsey	8534	15-9-39	22-8-45	273	5	5,745	5·01	288·28	Denmark Research Station	Koojan Ace's Goldseeker (3431)
Clovelly Bella	do.	8498	20-10-39	28-6-45	240	10	5,880	4·89	288·00	Mrs. L. R. Barnsby	Koojan Monogram (4174)
Muresk Romana	do.	9112	13-5-40	2-6-45	273	16	5,928	4·84	287·40	Muresk Agricultural College	Muresk Homestead (2075)
Narrogin Maisie	A.I.S.	32146	1-11-38	22-3-45	273	16	7,533	3·76	283·22	Narrogin School of Agriculture	Wooroloo Stirling 3rd (3626)
Clovelly Margaret	Guernsey	6929	20-11-37	24-7-45	273	6	5,688	4·94	281·25	Mrs. L. R. Barnsby	Nornabank Brian (3640)
Eungella Bo-Peep	Jersey	71246	27-12-37	6-4-45	273	16	6,408	4·36	279·48	D. G. Spark	Greenmount Golden Sovereign (14867)
Rosella Queen	Guernsey	9315	3-7-39	16-6-45	240	8	6,000	4·63	278·16	Darnel Bros.	Muresk Paul (4356)
Clovelly Golden Dawn	do.	8499	15-10-39	7-6-45	273	7	5,421	5·05	274·00	Mrs. L. R. Barnsby	Koojan Monogram (4174)
Koojan Golden Ripple	do.	7248	26-3-38	16-5-45	273	11	5,673	4·80	272·86	Denmark Research Station	Homestead Ace (Imp.) (1631)
Clovelly Queen	do.	6930	1-7-36	27-6-45	273	6	5,928	4·57	270·96	Mrs. L. R. Barnsby	Koojan Sir Garnet (847)
Pleuarbor Tulip	A.I.S.	....	4-4-40	18-8-45	273	4·5	7,513	3·59	270·46	Mrs. V. Alexander	Alne Bank Tena's Gift (1766)
Glenavon Eva 3rd	do.	36547	30-5-40	7-10-45	240	16	6,600	4·01	264·75	M. H. Montgomery	Blackland's Jean's Supreme (1871)

TABLE 9—HERD TESTING—continued.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Entry to Test.	No. of Days in Test.	Weight of Milk Last Day of Test. lb.	Weight of Milk for Period. lb.	Average Test. %	Weight of Butter Fat for Period. lb.	Owner.	Sire.
COWS 5 YEARS AND OVER STANDARD 350 LB BUTTER-FAT—*continued.*											
Brookfield's Gloria	Guernsey	8384	2-2-40	16-10-45	180	12	4,935	5·31	262·05	P. G. Hampshire & Sons	Brookfield's Baron (3936)
Glanavon Fairy 5th	A.I.S.	36548	25-3-40	21-5-45	273	14	6,282	4·08	256·49	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Clovelly Duchess	Guernsey	8497	8-7-38	23-5-45	273	6	5,268	4·84	255·45	Mrs. L. R. Barnsby	Muresk Nelson (3620)
Juadine Peerless Lily 17th	Jersey	81991	18-12-39	10-5-45	273	5	4,050	6·12	247·80	Mrs. A. G. Eckersley	Austral Park Wonderful Std. (14243)
Mereworth Starbright's Vanilla 3rd	do.	77709	12-6-38	15-6-45	150	31·5	4,860	5·01	243·78	B. Langridge	Mereworth Rye Duke (13953)
Yanget Graceful 4th	A.I.S.	....	9-10-39	28-8-45	240	14	6,735	3·61	243·66	Mrs. V. Alexander	Maylands Defiance (2380)
Narrogin Donna	do.	32144	27-10-39	11-5-45	273	13·5	6,535	3·07	242·59	Narrogin School of Agriculture	Wooroloo Stirling 3rd (3626)
Muresk Angelica	Guernsey	9101	10-9-39	17-9-45	273	5	5,115	4·64	237·66	Muresk Agricultural College	Muresk Homestead (2075)
Muresk Golden Pearl	do.	9107	9-10-39	1-11-44	273	8	4,494	5·17	232·47	Muresk Agricultural College	Muresk Homestead (2075)
Muresk Treasure	do.	9118	12-7-39	25-5-45	273	7	4,131	5·24	220·76	Muresk Agricultural College	Muresk Homestead (2075)
Narrogin Minnie	A.I.S.	38671	25-11-39	26-4-45	273	11	4,923	4·44	218·86	Narrogin School of Agriculture	Wooroloo Stirling 3rd (3626)
Muresk Sunbeam	Guernsey	9117	30-11-39	14-12-44	273	10	4,320	5·04	217·72	Muresk Agricultural College	Muresk Homestead (2075)
Westby Laurel	A.I.S.	40986	7-2-40	23-4-45	273	15	5,730	3·74	214·51	Narrogin School of Agriculture	Westby Searchlight (3604)
Denmark Velveteen	Guernsey	8541	24-7-39	13-7-45	273	6·5	4,429	4·79	212·47	Denmark Research Station	Koojan Ace's Goldseeker (3431)
Mereworth Oxford's Vanilla 2nd	Jersey	87804	15-2-40	22-6-45	150	21	3,810	5·46	208·14	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)
Mereworth's Starbright Audrey 4th	do.	67932	10-9-37	29-3-45	210	17	43,95	4·72	207·78	B. Langridge	Grantham Merry Starbright (9547)
Yanget Daphne 5th	A.I.S.	34021	15-9-38	15-4-45	240	10	5,205	3·90	203·37	Mrs. V. Alexander	Blacklands Lancer (1874)
Narrogin Aster	do.	32142	1-6-39	7-6-45	240	10	5,850	3·46	202·89	Narrogin School of Agriculture	Wooroloo Stirling 3rd (3626)
Plenarbor Dandelion	do.	39210	30-12-39	27-3-45	240	8	5,400	3·71	200·43	Mrs. V. Alexander	Tipperary Empress Monarch (4436)
Muresk Delia	Guernsey	9105	11-5-39	24-5-45	273	9	4,587	4·26	195·79	Muresk Agricultural College	Denmark Damon (2519)
Narrogin Charlotte	A.I.S.	38663	13-4-40	16-5-45	210	9·5	5,310	3·61	192·00	Narrogin School of Agriculture	Westby Masterpiece (5403)
Rosella Duchess 2nd	Guernsey	....	7-5-39	15-8-45	180	12	3,630	5·25	190·86	Darnell Bros.	Muresk Paul (4356)
Mereworth Starbright's Belvedere 6th	Jersey	87805	19-4-39	4-6-45	150	24	3,660	4·88	178·65	B. Langridge	Walgett Campanile's Chief (16167)
Yanget Gwen	A.I.S.	23301	12-10-35	2-6-45	210	11·5	5,280	3·11	174·24	Mrs. V. Alexander	Sunrise of Parkview (1875)
Mereworth Oxford Belvedere	Jersey	....	26-3-40	12-4-45	210	14·5	3,885	4·46	173·37	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)

Westby Polly	A.I.S.	15141	21–5–32	2–6–45	210	8·5	4,935	3·51	173·19	Narrogin School of Agriculture	Telyarup Duke (956)
Mereworth Oxford Silvermine	Jersey	87803	28–4–40	7–6–45	150	20	3.765	4·54	171·00	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)
Tipperary Lovely 4th	A.I.S.	....	29–6–40	17–8–45	180	13	4,905	3·39	166·40	M. H. Montgomery	Blackland's Monarchs Commander (1877)
Mereworth Oxford Carnation	Jersey	....	13–2–39	13–3–45	180	14·5	3,375	4·78	161·46	B. Langridge	Grantham Easter's Oxford (14677)
Claremont Duchess 2nd	A.I.S.	9920	17–10–33	28–12–44	273	6·5	4,943	3·19	157·75	Narrogin School of Agriculture	Tipperary Virginia's Re-echo (970)
Claremont Flora	do.	15961	27–8–34	26–2–45	240	5·5	4,485	3·49	156·81	Narrogin School of Agriculture	Claremont Herdsman (968)
Brookfield's Duchess	Guernsey	6835	3–6–37	25–9–45	210	3·5	3,105	4·93	153·12	Darnell Bros. ...	Brookfield's Majesty (3254)
Claremont Cherry 9th ...	A.I.S.	15955	25–11–34	14–5–45	240	8	4,680	3·24	151·77	Narrogin School of Agriculture	Tipperary Virginia's Re-echo (970)
Denmark Golden Dawn 2nd	Guernsey	8527	2–4–40	19–9–45	240	4·5 6	2,505	5·76	144·51	Denmark Research Station	Koojan Ace's Goldseeker (3431)
Crantock Napoleon's Daffodil	Jersey	75813	22–10–37	7–10–45	60	36	2,310	5·90	136·38	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Rosella Queenie	Guernsey	9316	20–9–39	13–8–45	150	13	2,880	4·59	132·30	Darnell Bros.	Muresk Paul (4356)
Rosella Sweetheart	do.	....	30–7–40	27–11–45	150	8	2,880	4·53	130·56	Darnell Bros.	Muresk Paul (5456)
Narrogin Daisy	A.I.S.	38667	20–11–9	20–5–45	150	7	2,850	4·36	124·41	Narrogin School of Agriculture	Wooroloo Stirling 3rd (3626) ....
Mereworth Easter Princess 2nd	Jersey	82785	23–7–38	20–8–45	90	29	2,880	4·34	122·19	B. Langridge	Grantham Easter's Oxford (14677)
Mereworth Rye Buttercup	do.	67930	29–6–38	9–8–35	60	43	2,730	4·36	119·19	B. Langridge	Mereworth Rye's Duke (13953)
Rosella Lady Luck	Guernsey	9313	28–7–38	12–10–45	180	1·5	2,625	4·49	117·93	Darnell Bros.	Brookfield's Baron (3936)
Mereworth's Starbright's Audrey 5th	Jersey	....	13–3–40	17–7–45	120	13	2,445	4·60	112·59	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)
Brookfield's Primrose	Guernsey	5331	24–2–35	11–10–45	180	1·5	2,145	4·49	96·48	Darnell Bros.	Koojan Ace's Majestic (2735)
Mereworth Oxfords Starbright	Jersey	....	15–5–40	22–8–45	60	29	1,890	4·87	92·13	B. Langridge	Clarendon Eyre Oxford Pioneer (11484)
Norynia Nanette	do.	....	9–6–39	26–12–46	90	19	1,710	5·16	88·38	Mrs. A. G. Eckersley	Austral Park Wonderful Standard (12423)
Grassvale Design's Maggie	do.	71637	25–11–37	6–10–45	30	51	1,530	4·58	70·20	R. H. Rose & Son	Grassvale Gold Boy (14684)
Muresk Jessie	Guernsey	7641	2–5–37	14–8–45	30	35	1,050	4·37	45·90	Muresk Agricultural College	Muresk Homestead (2075)
Brookfield's Queen 8th	do.	10076	21–8–40	9–12–45	30	27	810	4·68	37·98	P. G. Hampshire & Sons	Yarraview Clarienet (4628)
Plenarbor Ruby	A.I.S.	32637	9–8–39	29–4–45	60	13	1,215	3·07	37·41	Mrs. V. Alexander	Tipperary Empress's Monarch (4436)
Mereworth Butter Queen 3rd	Jersey	67923	18–8–45	20–6–38	30	36	1,080	3·40	36·72	B. Langridge	Granthma Easter's Oxford (14677)
Brookfield's Queen 7th	Guernsey	8391	23–6–40	1–11–45	30	24	720	5·03	36·24	P. G. Hampshire & Sons	Yarraview Clarienet 2nd (4629)
Kiama Bess 14th	A.I.S.	37636	19–6–39	14–4–46	30	30	900	3·97	35·76	N. H. Montgomery	Kiama Trumper (3304)
Rosella Mayflower	Guernsey	9314	11–5–40	14–6–45	60	13	870	3·43	29·85	Darnell Bros.	Muresk Paul (4356)

Stock Foods.

The following Stock Foods have been registered at the Department of Agriculture under the Feeding Stuffs Act, 1924-1942, for the year commencing 1st July, 1946.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis. Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Lime (CaO).	Other.		Wholesale Price per ton at works (W); on rails Perth (P).
					%	%	%	%	%	%	%	%	£ s. d.
A.—SIMPLE FOODS.													
1.—*Meat Meals.*													
Meat Meal	2	ANCHO	Anchorage Butchers, Ltd.	Waste meat products	50·56	14·59	1·48	·56	9·39	11·24	....	....	12 5 0 (P)
Do.	3	STATE ABATTOIRS, MIDLAND JUNCTION	State Abattoirs	do. do.	50·63	19·00	2·60	....	....	....	....	....	12 7 6 (W)
Do.	18	PANNIFEX	Burridge & Warren, Ltd.	do. do.	40·00	8·00	3·00	....	....	....	....	....	15 10 0 (P)
Blood Meal	56	IMPERIAL	W. Angliss & Co. (Aust.) Pty., Ltd.	Animal offal	85·00	*Nil*	1·00	....	....	....	....	....	14 0 0† (W)
Meat meal	57	do.	do. do. do.	do. do.	60·00	10·00	1·00	....	....	....	....	....	10 10 0† (W)
Liver meal	58	do.	do. do. do.	do. do.	65·00	20·00	1·00	....	....	....	....	....	20 0 0† (W)
Meat Meal	61	EXCELSIOR	Barrow Linton & Co.	do. do.	45·00	10·00	1·50	....	....	....	....	....	12 8 4† (W)
Do.	89	J.K.S. No. 1	J. Kitchen & Son, Pty. Ltd.	Animal fat and bone meal	40·00	6·00	1·00	....	14·00	....	....	....	On application
Meat and Bone Meal	91	S.M.P.	W. R. & N. N. Clarke	Animal offal and bone meal	60·00	7·00	....	....	....	....	27%	Minerals	9 5 0 (W)
Do. do.	116	METE O VITE	Goldsbrough, Mort & Co. Ltd.	Meat Meal and Bone Meal	12·00	6·50	1·50	....	15·00	20·50	....	....	17 15 0† (P)
Meat Meal	131	WAME	The West Australian Meat Export Works	Meat, blood, and bone	45·00	9·50	....	....	....	....	....	....	On application
2.—*Bone Meals.*													
Bone Meal	1	ANCHO	Anchorage Butchers, Ltd.	Waste meat products	23·63	2·44	Trace	Trace	26·76	26·95	....	....	13 5 6 (P)
Do.	4	W.A.M.E.	West Australian Meat Export Works	Bones solely	18·75	....	....	0·25	26·00	27·00	....	....	11 10 0 (W)
Bone Flour	16	TRICALOS	Davis Gelatine (Aust.), Pty. Ltd.	Sterilised bone flour	5·00	....	....	....	32·50	40·00	....	....	11 15 0 (W)
Bone Meal	59	D.B.G.	W. Angliss & Co. (Aust.) Pty., Ltd.	Animal bones	....	....	....	....	28·00	36·00	....	....	14 0 0† (W)
3.—*Other.*													
Peanut Meal	5	ETA	Cruickshank Bros.	Peanut kernels	49·00	2·00	6·00	....	....	....	....	....	10 10 0† (F)
Milk Sugar Food	24	KRAFCO	Kraft Walker Cheese Co. Pty., Ltd.	Whey from cheese manufacture	10·00	0·50	*Nil*	....	1·00	0·70	Lactose 68·0	Riboflavin 25 u/gm.	25 10 0 (P)
Do. do.	25	LACTOKRAFT	do. do. do.	do. do. do.	10·00	0·50	*Nil*	....	1·00	0·70	68·0	25 u/gm.	28 0 0 (P)
Linseed Oil Meal	27	M.L.M.	Elder Smith & Co., Ltd..	Linseed	30·00	6·00	10·00	....	....	....	....	....	13 15 0 (F)
Roller Bran	31	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Wheat	8·50	*Nil*	5·00	....	....	....	....	....	9 2 0† (W)
Wheat Meal	32	do.	do. do. do.	do.	8·50	1·00	3·00	....	....	....	....	....	8 12 0 (W)

Wheaten Stock Meal	68	POLLATO	W. Thomas & Co. (W.A.), Ltd.	Crushed wheat	8·00	*Nil*	5·00	....	....	....	....	....	9 2 0	(W)
Stock Meal	69	STOCKMEAL	do. do. do.	do. do.	8·00	*Nil*	5·00	....	....	....	....	....	9 2 0	(W)
Do.	67	BRANATO	do. do. do.	do. do.	8·00	*Nil*	9·00	....	....	....	....	....	9 2 0	(W)
B.—COMPOUND FOODS. (1.) *Cattle Foods.* Cattle Food	20	EVE-LYN	Tropical Traders, Ltd.	Linseed meal, linseed whole, pollard, salt, limestone, chalk, animal charcoal, molasses, sulphur, sulphate of iron, copper sulphate, medicinal herbs	7·62	5·47	14·04	5·06	7·21	$CaCo_3$ 9·52	Sulphur. 2·66	Other Minerals and Herbs 3·80	†21 5 0	(P)
Sweetened Dairy Meal	33	WESFARMERS	Westralian Farmers Co-operative. Ltd.	Oat meal, bran, linseed meal, peanut meal, cocoanut meal, molasses, clover pollard, bone meal, bluestone, salt, calcium carbonate	15·00	2·00	4·00	1·00	....	As $CaCo_3$ Under 1·00	....	Trace Bluestone	10 4 0	(P)
Dairy Meal	34	do.	do. do. do.	Wheat meal, bran, cocoanut meal, peanut meal, linseed meal, bone meal, salt, copper sulphate, calcium carbonate	18·00	4·00	8·00	Trace	....	Under 5·00	....	Trace Bluestone	12 8 6	(P)
Sweet Dairy Food	70	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Wheat germ, molasses, bran, wheat meal, oatmeal or rolled oats, cocoanut or peanut or linseed meals*, meat meal*, dried yeast*, calcium carbonate, sodium chloride	15·00	3·00	8·50	Max. 1·50	....	Max. 3·75	....	....	9 10 0	(W)
"Milk Protein" or More Milk	71	do.	do. do. do.	Peanut or cocoanut or linseed meals*, wheat meal, meat or liver meals*, dried yeast*, calcium carbonate, sodium chloride	19·00	4·50	6·50	Max. 3·00	....	Max. 15·00	....	....	13 0 0	(W)
More Cream	72	do.	do. do. do.	Peanut or cocoanut or linseed meals*, whole linseed, wheat meal, meat or liver meal*, dried yeast*, calcium carbonate, sodium chloride	19 00	4·50	6·50	Max. 3·00	....	Max. 15·00	....	....	13 0 0	(W)
Dairy Meal	92	VETAMAC	A. H. McDonald & Co	Salt, sulphur, iron, bone meal, molasses, magnesium sulphate, sodium carbonate, potassium iodide, wheat meal, linseed meal, maize meal	10·00	2·50	5·00	26·0	....	CaO 1·80	Other Minerals 1·0		26 15 0	(P)

STOCK FOODS—continued.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis. Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Lime (CaO).	Other.	Wholesale Price per ton at Works (W) or on rails, Perth (P).
					%	%	%	%	%	%	% | %	£ s. d.
Lin Meal	101	WESTERN	David Gray & Co., Ltd.	Linseed meal, yeast meal, bone meal, calcium carbonate, malt	25·00	7·00	3·00	....	....	....	Trace	13 5 0 (P)
Milk Food	102	do.	do. do. do.	Linseed meal, peanut meal, yeast, bone meal, oat meal, calcium, carbonate	25·00	5·00	6·00	....	....	....	Other Minerals Trace	13 5 0 (P)
Sweet Dairy Food	104	do.	do. do. do.	Malt combings, yeast, oat meal, wheat meal, mill offal, linseed meal, calcium carbonate, salt	15·00	2·00	8·00	Trace	....	....	Trace	9 15 0 (P)
(2.) *Calf Foods.*												
Calf Food	17	STAR	Robt. Harper & Co., Ltd.	Oats, linseed, maize, barley, rice meals, condiments	12·50	12·50	6·00	....	....	....	.... |	18 0 0 (F)
Do.	23	EVE-LYN	Tropical Traders, Ltd. ...	Wheat, pollard, whole linseed, salt, sugar, chalk, sulphur, sodium bicarbonate, copper sulphate, medicinal herbs	10·75	4·77	3·86	2·89	....	....	Other 3·38	22 0 0 †(P)
Do.	26	PARSONS	Parsons Bros. & Co. Pty., Ltd.	Wheat, oat bran, linseed, limestone, salt	12·00	2·00	6·00	1·00	....	$CaCo_3$. 1·00	.... |	On application
Calf Meal	35	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Linseed meal, peanut meal, wheat meal, maize meal, butter milk, bone meal, liver meal,* bran, barley meal, salt, bluestone, calcium carbonate	18·00	5·00	8·00	Trace	....	Under 2·00	Trace	13 4 0 (P)
Calf Food	73	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Peanut or linseed or cocoanut meals*, milk powder*, wheat meals, whole linseed, oat meal or rolled oats*, meat meal or liver meal*, calcium carbonate, sodium chloride	15·50	4·50	5·00	Max. 3·00	....	$CaCo_3$. Max. 15·00	.... |	14 10 0 (P)
Do.	93	VETAMAC	A. H. McDonald & Co.	Wheat, pollard, maize meal, linseed meal, mutton bird oil	20·23	13·13	5·75	....	....	....	Mutton Bird Oil 10%	37 10 0 (P)

Do.	103	WESTERN	David Gray & Co., Ltd.	Linseed meal, oat meal, peanut meal, powdered milk, yeast, bone meal, trace minerals	20·00	4·00	7·00	....	2·00	CaO 2·00	....	....	14 5 0 (P)
Do.	117	KAF-O-VITE	Goldsbrough, Mort & Co., Ltd.	Rice meal, barley meal, wheat, pollard, linseed meal, bone charcoal, calcium carbonate, cane sugar, essence of aniseed	16·50	9·50	7·50	....	·80	1·50	....	....	26 0 0† (P)
(3.) *Sheep Foods.* Sheep Food	21	EVE-LYN	Tropical Traders, Ltd.	Linseed meal, whole linseed, pollard, salt, limestone, chalk, animal charcoal, molasses, sulphur, sulphate of iron, copper sulphate, medicinal herbs	9·81	5·95	14·79	5·82	4·34	10·15	Sulphur. 2·63	Other. 4·04	21 5 0† (P)
Meggits Linseed Sheep Nuts	28	M.L.M.....	Elder, Smith & Co., Ltd.	Linseed	30·00	6·00	10·00	....	....	....	....	....	13 15 0 (F)
Maintenance Sheep Cubes	36	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Oat meal, wheat meal, barley meal, clover pollard, linseed meal, peanut meal, cocoanut meal, salt, molasses, calcium carbonate	14·00	4·50	6·50	0·50	....	$CaCO_3$. Less than 1·00	....	....	11 16 0 (P)
Sheep Breeders Cubes	37	do.	do. do. do.	Oat meal, barley meal, wheat meal, clover pollard, linseed, peanut and cocoanut meals, molasses, salt, calcium carbonate	18·00	7·50	7·50	0·50	....	$CaCO_3$. Less than 1·00	....	....	14 14 0 (P)
Maintenance Sheep Nuts	105	WESTERN	David Gray & Co., Ltd.	Linseed meal, yeast meal, calcium carbonate, bone meal, salt, trace minerals	16·00	3·00	7·00	0·50	....	1·50	....	Trace	11 14 0 (P)
Ewe and Lamb Nuts	106	do.	do. do. do.	Linseed meal, yeast meal, bone meal, malt, wheat germ, salt, trace minerals	25·00	3·00	7·00	0·50	....	1·50	....	Trace	13 19 0 (P)
(4.) *Poultry Foods.* Laying Mash No. 1	38	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Wheat meal, pollard, bran, oat meal, meat meal, butter milk, linseed meal, liver meal*, salt, bone meal, calcium carbonate	17·50	4·00	7·00	Less than 1·00	....	$CaCO_3$. 2·00	....	....	9 13 6 (P)
Laying Mash No. 2	39	do.	do. do. do.	Wheat meal, roller bran, bran, linseed meal, butter milk, salt, bone meal, calcium carbonate	14·00	3·00	7·00	1·00	....	Less than 3·00	....	....	9 13 6 (P)
Laying Pellets No. 1	40	RED COMB ...	do. do. do.	Wheat meal, pollard, bran, oat meal, meat meal, butter milk, linseed meal, liver meal*, bone meal, salt, calcium carbonate	17·50	4·00	7·00	Less than 1·00	....	2·00	....	....	10 3 6 (P)

STOCK FOODS—continued.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis.								Wholesale Price per ton at Works (W) or on rails Perth (P).
					Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Lime (CaO).	Other.		
					%	%	%	%	%	%	%	%	£ s. d.
Laying Pellets No. 2	41	RED COMB	Westralian Farmers Co-operative Ltd.	Wheat meal, roller bran, bran, linseed meal, butter milk, bone meal, salt, calcium carbonate	14·00	3·00	7·00	1·00	....	Less than 3·00	....	....	10 3 6 (P)
Growers Pellets	42	do.	do. do. do.	Wheat meal, pollard, bran, butter milk, meat meal, salt, calcium carbonate	14·00	4·00	5·00	Less than 1·00	....	Less than 2·00	....	....	11 13 6 (P)
Growers Mash	43	WESFARMERS	do. do. do.	Wheat meal, pollard, bran, butter milk, meat meal, salt, calcium carbonate	14·00	4·00	5·00	Less than 1·00	....	Less than 2·00	....	....	11 3 6 (P)
Protein Meal "A"	44	do.	do. do. do.	Bone meal, meat meal, butter milk, liver meal*, maize meal, calcium carbonate	42·00	9·00	2·00	....	....	$CaCO_3$ 8·00	....	....	17 2 6 (P)
Protein Meal "B"	45	do.	do. do. do.	Meat meal, liver meal*, bone meal, linseed meal, calcium carbonate	45·00	9·00	3·00	....	....	10·00	....	....	15 5 0 (P)
Egg Laying Mash	63	EGGLAYER	Barrow Linton & Co.	Bran, pollard, wheat meal, lime, oat pollard, meat meal, salt	17·15	3·50	4·25	1·00	....	2·00	....	....	11 0 0 (W)
Laying Mash No. 1	76	THOMAS ...	W. Thomas & Co. (W.A.), Ltd.	Bran, pollard, wheaten meals, oat meal*, meat meal, wheat germ, dried blood*, dried yeast*, milk powder*, dehydrated lucerne meal*, calcium carbonate, salt, liver and fish meals*	17·00	4·50	7·50	1·50	....	Max. 3·75	....	....	9 12 6 (P)
Laying Mash No. 2	77	do.	do. do. do.	Bran, pollard, wheaten meal, wheat germ, peanut or cocoanut or linseed meals*, meat meal*, dried blood*, dried yeast*, milk powder*, oat meal*, dehydrated lucerne meal*, fine salt, calcium carbonate	15·50	4·50	7·50	1·50	....	Max. 3·75	....	....	9 12 6 (P)

Special Laying Mash with Liver Meal	78	THOMAS ...	W. Thomas & Co. (W.A.) Ltd.	Bran, pollard, wheat meal, liver meal, calcium carbonate, sodium chloride	18·00	2·50	7·50	1·50	....	CaCo$_3$ Max. 3·75	....	....	9 16 0 (P)
Quick Lay	79	do.	do. do. do.	Meat meal, dried blood, bone meal, liver meal*, milk powder*, peanut or cocoanut or linseed meals*, wheaten meal, dried yeast*, fish meal*, calcium carbonate, sodium chloride, potassium iodine*	35·00	7·00	4·00	Max. 3·00	....	Max. 15·00	....	....	14 15 0 (W)
Egg Milk	80	do.	do. do. do.	Milk powder, linseed or cocoanut or peanut meals*, wheat meal, dried yeast*, calcium carbonate, sodium chloride	21·50	4·00	2·00	Max. 3·00	....	Max. 15·00	....	....	24 10 0 (P)
Laying Mash "A"	99	WESTERN	David Gray & Co., Ltd.	Bran, pollard, wheat meal, meat meal, bone meal, linseed meal, yeast, calcium carbonate	17·00	3·00	7·50	....	Max. 2·00	1·50	....	....	9 13 6 (P)
Laying Mash "B"	98	do.	do. do. do.	Bran, pollard, wheat meal, yeast, bone meal, linseed meal, calcium carbonate	15·00	3·00	7·50	....	2·00	1·50	....	....	9 13 6 (P)
Egg Food	100	do.	do. do. do.	Meat meal, blood meal, liver meal, linseed meal, yeast meal, malt, bone meal	44·00	6·00	4·00	....	....	CaCo$_3$ 5·00	....	....	15 5 0 (P)
Laying Mash	107	MORLAY	Robert B. Young	Wheat meal, bran, pollard, meat meal, bone meal, oyster shell flour and other minerals	16·75	3·00	6·00	1·20	1·28	CaO. 1·56	....	....	11 5 0 (W)
Laying Allmash	108	do.	do. do.	Wheat meal, bran, pollard meat meal, bone meal, oyster shell flour and other minerals	15·25	3·00	6·25	1·00	1·50	1·50	....	....	10 15 0 (W)
Laying Mash "B"	109	do.	do. do.	Wheat meal, bran, pollard, bone meal, linseed or cocoanut meals*, oyster shell flour and other minerals	14·00	3·50	6·25	1·15	1·50	1·56	....	....	11 5 0 (W)
Poultry Food	60	EGGOLEEN	Barrow, Linton & Co.	Meat meal, liver meal, bone meal, butter milk powder, salt, and other minerals	40·00	9·00	1·50	2·00	....	Max. 2·00	....	....	16 0 0 †(W)
Fattening Mash	62	DUKKO	do. do.	Bran, pollard, wheat meal, oat pollard, cocoanut, bone meal, biscuit meal, salt, lime	15·00	4·20	2·00	1·00	....	2·00	....	....	10 15 0 (P)
Growing Mash	64	GROWELL	do. do.	Bran, pollard, wheat meal, oat pollard, maize, meat meal, limestone, salt, wheat germ, dried blood	16·90	3·95	4·56	1·00	....	2·00	....	....	10 12 6 (W)

STOCK FOODS—continued.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis. Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Lime (CaO).	Other.	Other.	Wholesale Price per ton at Works (W) or on rails, Perth (P).
					%	%	%	%	%	% $CaCo_3$	%	%	£ s. d.
Fattening Mash	81	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Oat or barley meals*, wheat germ, bran, pollard, wheaten meals, peanut or cocoanut or linseed meals* milk powder*, dried yeast*, dehydrated lucerne meal*, sodium chloride, calcium carbonate	14·50	3·50	8·00	1·50	....	Max. 3·75	....	....	9 15 0 (P)
Quick Grow	87	do.	do. do. do.	Meat, blood and bone meals, wheat meal, dried yeast*, oil meals*, calcium carbonate, sodium chloride	30·00	10·00	4·00	Max. 3·00	....	Max. 15·00	....	....	13 5 0 (W)
Growing Mash	110	MORLAY	Robert B. Young	Wheat meal, bran, pollard, meat meal, bone meal, buttermilk, oyster shell flour and other minerals	14·50	2·50	5·75	1·05	1·99	1·95	....	....	11 0 0 (W)
Growing Allmash	111	do.	do. do.	Wheat meal, bran, pollard, meat meal, bone meal, oyster shell flour, butter milk powder and other minerals	13·75	3·00	6·00	1·17	1·04	1·75	....	....	10 10 0 (W)
D Mash (Fattening Mash)	112	do.	do. do.	Wheat meal, bran, pollard, bone meal, linseed or cocoanut meal*, and other minerals	13·50	4·00	6·50	1·15	1·55	1·50	....	....	10 15 0 (W)
Starting Mash	65	VITALIZER	Barrow, Linton & Co.	Bran, pollard, wheat meal, oat pollard, meat meal, milk powder, lime stone, dried blood, wheat germ, fish oil, salt	16·95	4·00	4·50	1·00	....	2·00	....	....	14 15 0 (W)
5. *Chick Foods.* Chicken Mash	29	PATRIOT	J. & W. Bateman, Ltd.	Pollard, bran, meat meal, oat meal, powdered milk, bone meal, maize meal, chick feed	15·80	4·20	4·30	....	....	....	....	....	28 0 0 (P)
Chick Food	30	do.	do. do. do.	Cracked wheat, pannicum seed, broken peas, broken maize, shell grit	11·80	3·00	3·80	....	....	....	....	....	19 0 0 (P)

Chick Mash "A"	46	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Wheat meal, pollard, bran, butter milk, maize meal, meat meal, liver meal*, cod liver oil, manganese sulphate, salt, calcium carbonate	17·00	4·00	5·00	Less than 1·00	....	$CaCo_3$ Less than 2·00	Cod Liver Oil 2·00	Manganese Sulphate Trace	13 6 0 (P)
Chick Mash "B"	47	do.	do. do. do.	Wheat meal, pollard, bran, maize meal, butter milk, meat meal, cod liver oil, calcium carbonate, salt	15·00	4·00	5·00	Less than 1·00	....	$CaCo_3$ Less than 2·00	Cod Liver Oil 1·00	....	12 6 0 (P)
Chick Pellets "A"	48	RED COMB	do. do. do.	Wheat meal, pollard, bran, butter milk, maize meal, meat meal, liver meal*, cod liver oil, calcium carbonate, manganese sulphate, salt	17·00	4·00	5·00	Less than 1·00	....	2·00	Cod Liver Oil 2·00	Manganese Sulphate Trace	13 13 6 (P)
Chick Pellets "B"	49	do.	do. do. do.	Wheat meal, pollard, bran, maize meal, butter milk, meat meal, cod liver oil, calcium carbonate, salt	15·00	4·00	5·00	Less than 1·00	....	$CaCo_3$ Less than 2·00	Cod Liver Oil 1·00	....	12 16 0 (P)
Chick Food	51	ANCHOR	G. Wood, Son & Co., Ltd.	Rolled wheat, maize, yeast meal, butter milk powder, millet, oyster grit	13·00	3·00	6·00	....	....	....	....	....	18s. 6d. per doz. 6 lb. bags
Chick Grain	66	CHIC CHIC	Barrow, Linton & Co.	Wheat, oats, maize, blue peas	10·50	3·00	5·10	....	....	....	....	....	12 17 6 (W)
Chicken Grain	82	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Wheat, maize, or Peas or oats*, shell grit	12·50	2·30	5·50	....	....	....	....	....	12 5 0 (P)
Chick Starter	83	do.	do. do. do.	Wheat germ, bran, pollard, meat meal, cod liver oil, wheat meal, maize or pea meal*, milk powder, dried yeast*, dehydrated lucerne meal*, oat meal or rolled oats*, calcium carbonate, bone meal, oil meals*, fish meal*, sodium chloride	16·50	4·00	6·00	Max. 1·00	....	$CaCo_3$ Max. 3·75	....	....	13 0 0 (P)
Chick Grower	84	do.	do. do. do.	Wheat germ, bran, pollard, meat meal, wheat meal, milk powder*, dried yeast*, dehydrated lucerne meal*, oat meal or rolled oats*, calcium carbonate, sodium chloride, fish meal*	14·50	3·50	7·00	Max. 1·50	....	$CaCo_3$ Max. 3·75	....	....	11 5 0 (P)

STOCK FOODS—continued.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis.								Wholesale Price per ton at Works (W) or on rails, Perth (P.)
					Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Lime (CaO).	Other.		
					%	%	%	%	%	%	%	%	£ s. d.
Chicken Milk No. 1	85	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Milk powder, meat meal, bone meal, peanut or cocoanut meals*, dried yeast*, calcium carbonate, sodium chloride, fish meal*	20·50	3·50	6·00	Max. 3·00	....	Max. 15·00	....	...	17 10 0 (P)
Chicken Milk No. 2	86	do.	do. do. do.	Milk powder, peanut or cocoanut meals*, wheat meal, dried yeast*, calcium carbonate, sodium chloride	18·00	3·00	7·00	Max. 3·00	....	Max. 15·00	....	....	17 10 0 (P)
Chick Builder	96	WESTERN	David Gray & Co., Ltd.	Pollard, bran, maize meal, wheat corn, butter milk, meat meal, bone meal, yeast, cod liver oil	15·00	3·00	5·00	....	Max. 2·00	1·50	....	....	11 15 0 (P)
Chick Starter	97	do.	do. do. do.	Pollard, bran, maize meal, wheat meal, yeast, wheat germ, butter milk, bone meal, meat meal, cod liver oil	17·00	3·00	4·50	....	2·00	1·50	....	....	13 10 0 (P)
Chick Starter	113	MORLAY	Robert B. Young	Bran, wheat meal, maize meal, meat meal, bone meal, cod liver oil, butter milk powder, shell grit and minerals	17·00	3·00	4·75	·98	2·10	5·00	....	....	15 5 0 (W)
Chick Mash	114	do.	do. do.	Wheat meal, bran, maize meal, meat meal, bone meal, butter milk powder, shell grit and minerals	16·50	3·00	5·50	1·59	1·06	4·08	....	....	13 15 0 (W)
Chick Allmash	115	do.	do. do.	Wheat meal, bran, maize meal, meat meal, bone meal, butter milk powder, shell grit and other minerals	15·00	3·00	6·00	1·17	1·57	4·00	....	....	13 0 0 (W)
6. Pig Foods.													
Pig Food	19	EVE-LYN	Tropical Traders, Ltd.	Pollard, linseed meal, linseed (whole), salt, lime stone, chalk, sulphur, animal charcoal, sulphate of iron, limonite, copper sulphate, medicinal herbs	10·25	10·51	12·35	2·12	4·44	9·60	Sulphur. 3·76	Other Minerals and Herbs† 2·73	26 8 0 (P)

Pig Starter	74	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Wheat, barley or oat meals, meat meal, dried blood. bone meal, oil meals*, dried yeast*, calcium carbonate, sodium chloride, fish meals*	15·50	3·50	7·00	1·50	....	CaCo$_3$ 3·75	....	....	9 0 0 (P)
Pig Grower	75	do.	do. do. do.	Wheat, oat or barley meals, malt screenings*, flax seed meal*, oil meals*, dried yeast*, calcium carbonate, sodium choride, meat and fish meal*	14·00	4·50	7·50	1·50	....	3·75	....	....	9 0 0 (P)
Pig Milk	120	do.	do. do. do.	Milk powder, linseed or cocoanut or peanut meals*, wheat meal, dried yeast*, calcium carbonate, sodium chloride	21·50	4·00	2·00	Max. 3·00	....	15·00	....	....	24 10 0 (P)
7. *Horse Foods.*													
Horse Food	22	EVE-LYN	Tropical Traders, Ltd.	Pollard, linseed meal, linseed (whole), wheat, salt, chalk, magnesium sulphate, sulphur, sulphate of iron, copper sulphate, sodium bicarbonate, medicinal herbs	12·87	5·64	7·14	5·09	1·01	1·54	Sulphur 1·84	Other. 5·33	†46 8 0 (P)
Sweet Horse Meal	88	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Bran, wheaten meal, oat meal, barley or wheaten screenings*, molasses, dried yeast, linseed meal*, sodium chloride, calcium carbonate	15·00	3·00	10·00	1·50	....	CaCo$_3$ Max. 3·75	....	....	9 5 0 (W)
8. *Dog Foods.*													
Dog Food	6	SNAPETTES....	Albert E. Robinson	Wheat, bone, meat, vegetable	15·25	13·00	4·00	....	4·00	CaO 5·00	....	....	4d. per lb.
No. 1 Dog Biscuits	7	SNAPS	do. do.	do. do. do.	15·00	4·00	2·00	....	3·50	4·00	....	....	6d. per lb.
Puppy Biscuits	8	do.	do. do.	do. do. do.	15·00	4·00	2·00	....	3·50	4·00	....	....	6d. per lb.
Hound Meal	9	do.	do. do.	do. do. do.	15·00	4·00	3·00	....	2·50	2·50	....	....	4d. per lb.
Plain Shapes	10	do.	do. do.	do. do. do.	15·00	4·00	2·00	....	3·50	3·50	....	....	6d. per lb.
Puppy Meal	11	do.	do. do.	do. do. do.	15·00	4·00	2·00	....	3·50	4·00	....	....	6d. per lb.
Charcoal Shapes	12	do.	do. do.	Wheat, bone, meat, vegetable, charcoal	14·00	3·00	6·00	....	2·50	2·56	....	....	6d. per lb.
Bone Shapes	13	do.	do. do.	Wheat, bone, meat, vegetable	15·00	4·00	2·00	....	3·50	4·00	....	....	6d. per lb.
Dog Biscuits	14	BOANS LOCAL	do. do.	do. do. do.	15·00	4·00	3·00	....	2·50	2·50	....	....	32s. per 100 lb.
Bone Shapes	15	SYMONDS	do. do.	do. do. do.	15·00	4·00	2·00	....	3·50	4·00	....	....	6d. per lb.
C. STOCK LICKS													
Di-calcic Lick	50	WESFARMERS	Westralian Farmers Cooperative, Ltd.	Salt, di-calcic phosphate	....	....	....	40·00	20·00	16·00	....	....	28 lb. bags 3s. 6d. each.
Syko Lick or Mineral Stock Food	52	SYKES'S	Sykes's (Aust.) Drench Ltd.	Sodium chloride, manganese sulphate, sterilised bone flour, sulphur sublimate, ferrous sulphate, potassium iodide cobalt, sulphate copper sulphate	....	....	....	70·00	5·60	4·40	10·00	1·05	13s. per packet.
Di-calcic Phosphate	53	C.S.M.L.	Cuming, Smith & Mt. Lyell F.F., Ltd.	Calcium phosphate, at least 90 per cent. of (P_2O_5) being as di-calcic phosphate	....	....	....	....	37·00	28·00	....	....	20 18 3 BF 21 18 3 Bu 22 18 3 Ge

STOCK FOODS—continued.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis. Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride	Phos. Acid (P_2O_5).	Lime (CaO).	Other.	Other.	Wholesale Price per ton at Works (W) or on rails, Perth (P.)
					%	%	%	%	%	%	% Fe	% Cu	£ s. d.
Copper Lick	54	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	Di-calcic phosphate, copper sulphate, salt	....	....	....	66·00	12·50	....	....	0·10	11 13 10 B
Denmark Lick Substitute	55	do.	do. do. do.	Limonite, sulphate of copper, salt	....	....	....	38·00	....	....	20·0	0·14	8 11 3 B 9 12 11 Bu
Di-calcic Lick	90	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Sodium chloride, calcium carbonate, trical-os, bone flour	....	....	....	37·00	16·00	33·00	....	Minerals	11 0 0 (P)
Medicated Lick	91	VETAMAC	A. H. McDonald & Co. ...	Salt, sulphate of iron, sodium, bi-carbonate, sulphur, magnesium sulphate, bone meal, potassium iodide, molasses, whole meal, aloes	....	....	....	53·00	5·70	7·50	....	4·75	23 12 0 (P)
Mineral Concentrate	95	VETSOLICK....	do. do. do.	Bone meal, sulphur, sodium bi-carbonate, magnesia sulphate, whole meal, sulphate of iron, carbo ligni, potassium iodide	....	....	....	*Nil*	11·00	14·00	....	18·8	27 14 0 (P)
Cobaltised and Copperised Concentrate D for Sheep	127	VITA LICK	Goldsbrough Mort & Co., Ltd.	Bone flour (degelatinised), bone charcoal, sodium sulphate (anhydrous), sulphur, limonite, potassium iodide, copper sulphate, cobalt chloride and meals derived from by-products of rice, cocoa and wheat	...	....	....	*Nil*	23·50	30·00	Max. Meals 21·50	5·10	32 10 0 (P)
Cobaltised and copperised Mixed D for Sheep	125	do.	do. do. do.	Bone flour (degelatinised), bone charcoal, sodium sulphate (anhydrous), sulphur, limonite, potassium iodide, copper sulphate, cobalt chloride and meals derived from by-products of rice, cocoa and wheat	....	....	....	Max 80·00	3·70	4·70	3·39 Molasses 3·50	0·78	11 10 0 (P)
Cobaltised and copperised concentrate G for Sheep	128	do.	do. do. do.	Bone flour (degelatinised), bone charcoal, limonite, flowers of sulphur, potassium iodide, copper sulphate, cobalt chloride, and meals derived from by-products of rice, cocoa and wheat	....	....	....	*Nil*	23·50	31·00	Meals 12·70	7·52	32 10 0 (P)

Cobaltised and copperised Mixed G for Sheep	126	do.	do.	do.	do.	Bone flour (degelatinised), bone charcoal, limonite, flowers of sulphur, potassium iodide, copper sulphate, cobalt chloride, and meals derived from the by-products of rice, cocoa and wheat	....	....	....	Max. 80·00	3·80	4·90	2·00 Molasses 3·00	1·20	11 10 0 (P)
Cobaltised and copperised Cattle Lick Concentrate D	121	do.	do.	do.	do.	Bone flour (degelatinised), bone charcoal, sodium sulphate (anhydrous), flowers of sulphur, potassium iodide, copper sulphate, cobalt chloride, and rice, cocoa and wheat meals	....	....	....	*Nil*	21·70	29·00	Max. Meals 15·30	7·20	32 10 0 (P)
Cobaltised and copperised Cattle Lick Concentrate G	122	do.	do.	do.	do.	Bone flour (degelatinised), bone charcoal, sodium sulphate (anhydrous), flowers of sulphur, potassium iodide, copper sulphate, cobalt chloride, and rice, cocoa and wheat meals	....	....	....	*Nil*	25·00	32·50	10·20	5·85	32 10 0 (P)
Cobaltised and copperised Cattle Lick Mixed D	123	do.	do.	do.	do.	Bone flour (degelatinised), bone charcoal, sodium sulphate (anhydrous), flowers of sulphur, potassium iodide, copper sulphate, cobalt chloride, and rice, cocoa and wheat meals	....	....	....	Max. 75·00	4·20	5·40	3·10 Molasses 5·00	1·60	12 0 0 (P)
Cobaltised and copperised Cattle Lick Mixed G	124	do.	do.	do.	do.	Bone flour (degelatinised), bone charcoal, sodium sulphate (anhydrous), flowers of sulphur, potassium iodide, copper sulphate, cobalt chloride, rice, cocoa, and wheat meals	....	....	....	Max. 75·00	4·40	5·80	Max. Meals 1·93 Molasses 5·00	1·40	12 0 0 (P)
Vita Lick Mineral Mixture	120	V.M.M.	do.	do.	do.	Bone flour (degelatinised), bone charcoal, Spanish iron oxide, ferrous sulphate, flowers of sulphur, sodium sulphate (anhydrous), and meals derived from rice and cocoanut	....	....	....	4·30	9·50	12·50	Max. Meals 60·20	4·47	19 10 0 (P)
Mineralised Blocks	119	VITA LICK	do.	do.	do.	Carbonate of lime, sulphur, sulphate of iron, salt, potassium iodide, cobalt chloride	....	....	....	Max. 76·00	....	9·50	....	0·72	16 10 0† (P)

STOCK FOODS—continued.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis.								Wholesale Price per ton at Works (W) or on rails, Perth (P.)
					Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Lime (CaO).	Other.		
					%	%	%	%	%	%	%	%	£ s. d.
Chic-a-Vite	118	CHIC-A-VITE	Goldsbrough, Mort & Co., Ltd.	Bone flour (degelatinised), bone charcoal, ferrous sulphate, flowers of sulphur, sodium sulphate (anhydrous), gentian, cod liver oil, potassium iodide, and meal derived from by-products of rice	....	....	....	*Nil*	20·70	27·6	Max. Meals 16·50 Cod Liver Oil 2·50	10·39	36 0 0 (P)
Por-co-vite	129	POR-CO-VITE	do. do. do.	Bone flour (degelatinised), bone charcoal, sodium sulphate (anhydrous), flowers of sulphur, sodium chloride, limonite, calcium carbonate, copper sulphate, cobalt chloride, potassium iodide, and cod liver oil	....	....	....	13·00	19·10	30·00	Cod Liver Oil 3·56	12 90	35 0 0 (P)

BF, Bassendean-Fremantle. Bu, Bunbury. Ge, Geraldton. * Included only when available. † Short ton. ‡ Cost at Works.

Errata.

In the *Journal of Agriculture*, Vol. XXIII., No. 1, March, 1946:—

Page 22, paragraph 6, line 6, for "It is possible however, that the lack of sensitivity of the Resazurin to cell content . . . " to read "It is not possible . . . "

Page 22, paragraph 6, last line for "considerably increased compared with the freshly drawn sample" substitute "considerably decreased compared with the freshly drawn sample."

Page 42, "Flax Rust in Western Australia," line 1, for "Flax rust is caused by a fungus *Melampsore lini*" read "Flax rust is caused by *Melampsora lini*."

Page 45, References, (3) ———— 1944, for "Further determinations of Specialisation in Flax Rust caused by *Melampsore lini*" read "Further determinations of Specialisation in Flax Rust caused by *Melampsora lini*."

In the *Journal of Agriculture*, Vol. XXIII., No. 2, June, 1946, page 135, for "COMEBACK AND CROSSBRED FLOCKS OF UP TO 500 SHEEP" in the second heading read "COMEBACK AND CROSSBRED FLOCKS OF OVER 500 SHEEP."

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Strain 19 Vaccine in the Control of Contagious Abortion.

C. R. Toop, Asst. Chief Veterinary Surgeon.

EARLY this year Strain 19 vaccine became available for the control of contagious abortion in cattle and a scheme for the use of this product in dairy herds was outlined by this Department. Since that time a large number of heifers have been vaccinated by Departmental Officers in the dairying districts throughout the State and the work is still continuing.

Observations in other countries notably the United States and New Zealand where Strain 19 vaccine has been extensively used in the field for a number of years, have amply demonstrated the ability of this product to greatly reduce the abortion rate and so reduce the wastage caused by the disease. Since there is no reason to doubt that similar results will not be obtained in this country, the use of Strain 19 vaccine may be strongly recommended and it is hoped that dairy farmers will freely avail themselves of the advantages which it offers. As a background to a discussion upon the use of this vaccine it is perhaps advisable to mention briefly some of the more salient features of the disease which should lead to a better understanding of the problems presented by its control.

Its importance cannot be over-emphasised. It is widely distributed throughout the dairying areas of the State and a considerable proportion of the herds are infected. As a source of loss to the industry it is second only in importance to mastitis. It is responsible not only for the loss of the calf but for a considerable reduction of milk yield which has been estimated at from 25 to 30 per cent. In addition sterility resulting from metritis or inflamation of the uterus and retention of the afterbirth frequently occurs as a sequel to the disease. Sterility may become a serious problem in the herd and, unless steps are taken to overcome it by appropriate veterinary treatment, may result in the culling of many valuable animals.

Contagious abortion results from infection with a micro-organism known as *Brucella abortus* which invades the pregnant uterus setting up an inflammatory reaction which causes the death and premature expulsion of the calf. The majority of abortions occur between the 5th and 7th months but the calf may be lost as early as the third or as late as the 8th month of pregnancy.

The disease is spread by the fluids which are discharged from the uterus at the time of abortion, by the aborted calf and afterbirth, and by the discharges passed out by the cow for several weeks after abortion has occurred. All of these discharges contain enormous numbers of the Brucella organisms which contaminate the pastures and are picked up by other cattle while grazing. Similarly the disease may be spread by infected cattle which do not abort but which pass out infective discharges following normal calving. In this connection it should be recognised that all cows which become infected do not abort and that the majority of cows that have aborted once do not abort a second time. Such animals are, however, potentially dangerous. They usually remain infected and are carriers of the disease, contaminating the pastures by the discharges voided at the time of calving. All of the available evidence indicates that the bull plays little or no part in the dissemination of the disease. In the great majority of cases contagious abortion is introduced on to a property by the purchase of infected cows or heifers. Consequently in herds which have to rely upon the purchase of female stock for replacements, a serious risk of introducing the disease is always present.

When the disease is introduced into a clean herd it frequently runs an acute course resulting in a large number of abortions which may occur in rapid succession giving rise to the well known abortion storm. After a season or two the disease usually subsides and a stage is reached in which fewer abortions occur and these are principally confined to heifers and young cows. As a result of exposure to infection the majority of the older members of the herd have developed an immunity or resistance to the disease and are able to carry their calves to full term. No such immunity is enjoyed by heifers and young cows and for the protection of such animals Strain 19 vaccine will be found of especial value.

Other Methods of Control Inadequate.—Prior to the advent of Strain 19 vaccine the means which had been available for the control of the disease could neither be regarded as highly effective nor economically sound. The application of hygienic measures had always been advocated and had to a greater or lesser degree been practised by the dairy farmer. They have involved the destruction of the aborted calf and its membranes by burning or deep burial together with the application of a liberal dressing of quicklime to the surrounding area and the strict isolation of the aborting cow for 3-4 weeks until all discharges have ceased. While such measures when thoroughly applied may, and do check the spread of infection, it is obvious that they have not provided an effective means of controlling the disease. Hygienic measures should not, however, be neglected and this remark will apply with equal force even when the vaccination of the heifers in the herd with Strain 19 vaccine is being practised.

Under West Australian conditions there has been little scope for the test and slaughter method of control which is based upon a blood test known as the agglutination test. All members of the herd six months old and over are tested at monthly intervals and all animals giving a positive reaction are removed for immediate slaughter. The process is continued until two consecutive completely negative tests are obtained when the herd is declared abortion-free and is thereafter tested annually. While the advantages to be gained from the eradication of the disease by this method are obvious, being reflected by an increase in the number of viable calves, increased production and greater breeding efficiency, it is an extremely costly procedure and under our conditions must generally be regarded as impracticable, wasteful and economically unsound. For the most part its application could only be advocated

in well isolated herds in which the incidence of infection is low and which do not have to rely upon the purchase of cows or heifers from an outside source for replacement. It must further be recognised that the abortion-free herd is composed of highly susceptible animals and should the infection be re-introduced heavy losses would be likely to occur. There are few herds, however, in which the requirements set out above could be fulfilled.

Inoculating heifers with Strain 19 Vaccine.

IMMUNISATION WITH STRAIN 19 VACCINE.

This brings us to a consideration of Strain 19 vaccine and in view of the inadequacy of other methods of control it is fortunate that we now have in this product a weapon with which to fight the disease. For this product we are indebted to the American workers, Buck and Cotton, who during the course of their investigations were able to isolate a strain of *brucella abortus* of low virulence which we now know as Strain 19. This strain when injected into calves does not cause permanent infection or subsequent abortion and cannot be transmitted from one animal to another. It does, however, confer upon the treated animal a considerable degree of immunity or protection which enables it to resist infection when subsequently exposed.

Results in Other Countries.—In their early experiments these American workers vaccinated 70 calves 4-8 months old with Strain 19, keeping 73 unvaccinated calves as controls. These calves were subsequently mated and when pregnancy was well established, were submitted to a severe exposure test by instilling a few drops of culture of virulent Brucella organisms into the conjunctival sac of the eye. This infective dose would contain about 100,000,000 virulent organisms. In the 70 vaccinated animals only 4.3 per cent. of abortions occurred while in the unvaccinated controls the abortion rate was 73.5 per cent. This work was followed by extensive field trials. In one series involving 8,132 cattle vaccinated as calves and kept under observation for three pregnancies, 96.2 per cent. of the calvings were normal while only 3.8 per cent. of abortions occurred and less

than half of these resulted from Brucella infection. In 1941 Strain 19 was obtained from the U.S.A. by the Department of Agriculture, New Zealand, and similar observations were made. Fifteen heifer calves were vaccinated with Strain 19 and 15 unvaccinated calves were run with them as controls. When pregnant these heifers were subjected to an exposure test as the result of which nine of the unvaccinated animals aborted but only two abortions due to Brucella infection occurred in the vaccinated group. Concurrently large scale field trials in heavily infected herds were conducted. During 1942, 465 heifers were vaccinated and less than 5 per cent. of them subsequently aborted, whereas among 420 unvaccinated heifers running in the same group of herds during the previous year the abortion rate was 32 per cent. Amongst 293 of these vaccinated heifers which were under observation during their second pregnancy only four (1.4 per cent) abortions occurred. In 1943, 10,725 heifers were vaccinated and only 3 per cent. of them subsequently aborted. Twenty-two per cent. of the unvaccinated heifers in the same herds had aborted during the previous year.

Strain 19 vaccine is now being extensively employed for the control of contagious abortion in New Zealand. During 1944, 43,000 heifers were vaccinated and a further 107,000 were treated in 1945. In Victoria a total of 30,000 cattle had been vaccinated up to March 1st of the present year and the information made available indicated that the abortion rate in heifers in infected herds had been reduced from 26.4 to 5.2 per cent. In Great Britain 200,000 heifers were vaccinated during 1945.

These figures provide very convincing evidence of the ability of Strain 19 vaccine to control the disease and of the confidence of dairy farmers in the use of this product. In view of this evidence and the widespread distribution of contagious abortion, the widest possible use of Strain 19 vaccine in Western Australia is strongly recommended.

Facilities for Handling Cattle must be Provided.—For its part, this Department will undertake the vaccination of heifers throughout the dairying areas and is prepared to make officers available to carry out this work. A fee of 1/3 per head will be charged in order to defray the cost of the vaccine and the ear tags used for identification purposes. In order that the scheme may be successful the fullest cooperation on the part of dairy farmers will be necessary and it is requested that wherever possible vaccination centres be established to which the heifers from surrounding properties can be brought for treatment. It should be possible for a group of farmers working together to provide a well constructed crush and assistance of this kind will greatly facilitate the work of Departmental Officers and will considerably increase the number of heifers it will be possible to vaccinate. Without a crush the handling of heifers is a slow and difficult procedure. A crush 15-30 feet long (according to the number of cattle to be treated) with a space of about 8 inches between the rails, 4 feet 6 inches high and 20 inches wide provided with a forcing pen at the entrance and an exit gate for the release of the cattle after treatment, will meet requirements. Whatever type of crush is employed it should be strongly constructed in order that the cattle may be adequately restrained during treatment. Where the circumstances do not permit of heifers being brought to a vaccination centre, individual properties will be visited but it is emphasised that proper facilities for the handling of the cattle must in all instances be provided.

Vaccination of Heifers.—Heifers from the age of six months up to the time of mating may be vaccinated but it will probably be found most convenient, as the work proceeds, to vaccinate them annually as yearlings rather than as calves and there is reason to believe that better results will be obtained from treatment at this later age.

The information at present available indicates that the vaccination of heifers confers a high degree of protection for at least two pregnancies. It is reasonable, however, to expect that the immunity will weaken with the passage of time and more recent American work suggests that the protection obtained from the vaccine may be lost after the third pregnancy. Confirmatory evidence however, will be necessary before a definite pronouncement can be made upon this aspect of the matter.

Adult Cattle.—While a similar degree of protection may be obtained from the vaccination of adult cattle such work cannot generally be undertaken by Departmental Officers. The vaccination of the adult herd presents many problems. In the first place it is desirable that cows should be vaccinated while non-pregnant and this would necessitate a number of return visits to each property before the treatment of the whole herd could be completed. While vaccination in early pregnancy is unlikely to produce serious effects, abortion may occur if the pregnancy is advanced. Moreover, in herds in which the disease has existed for a long period, the abortion rate in the older cows is usually low and no great advantage could be anticipated from the vaccination of such animals. In the case of cows which have aborted or those which have already become infected (and many such animals are detected when the agglutination test is applied to infected herds) vaccination will not serve a useful purpose; neither could it be expected to check the progress of an abortion storm. On the other hand in herds in which perhaps one or two abortions have occurred and in which the disease is just commencing to gain a foothold, vaccination of the adult cattle would prove of the greatest value. Each herd however, would require to be dealt with on its merits and the action decided upon would largely depend upon the previous history of abortion in the herd.

Annual Vaccination.—There are no such problems with regard to heifers and it is considered with the small resources at our disposal that greatest benefit will be obtained by concentrating our attention on animals of this age. If we are able to devote the whole of our energies to the treatment of heifers this will enable a very large number to be vaccinated annually and within the space of a few years the herds participating in the scheme will be largely composed of immunised cattle and the menace of contagious abortion should thereby be correspondingly reduced. It is emphasised that the vaccination of heifers must be regarded as a long range project to be repeated annually if maximum benefits are to be obtained.

The vaccination of heifers is recommended both in clean and infected herds. The advantages to be obtained in the case of the infected herd are obvious and need not be emphasised. In the clean herd the procedure is equally sound and the vaccinated animals will be in a condition to resist the disease should infection be inadvertently introduced. The use of Strain 19 in a clean herd cannot result in the introduction of disease and the fears which are sometimes expressed by stock owners in this connection are groundless.

Effects of Vaccination.—Following vaccination a swelling develops at the site of inoculation. This gradually subsides but a period of several months may elapse before it finally disappears. This is accompanied by a systemic reaction during

which the animal becomes rather tucked-up in appearance and the appetite is reduced. The reaction is however, transient and subsides within a few days. In the case of cows there is usually a sharp decline (25-30 per cent.) in milk yield which sets in within 48 hours of vaccination and persists for about a week before a return to full production occurs.

Cattle vaccinated with Strain 19 develop a positive reaction to the agglutination test which cannot be differentiated from the reaction resulting from natural infection. In the case of calves these reactions subside fairly rapidly and all but about 5 per cent. of them become negative within 12 months. In adult cattle, however, the reaction persists for a much longer period. Under our conditions however, the development of a positive blood reaction is of little consequence. The principal consideration is that the abortion rate shall be reduced and the losses from the disease prevented. The persistence of a positive blood reaction is only likely to be of importance in the case of cattle which are intended for export to other States and countries and are required to be accompanied by a negative agglutination test certificate.

Application for Vaccination.—Owners desiring to participate in the scheme for the immunisation of heifers against contagious abortion are advised to make application to this Department. Application forms upon which it will be necessary to furnish particulars of the herd and of the previous history of abortion, will be provided. These should be completed and returned either direct to the Department or through a local farmers' organisation which has undertaken to make arrangements for the vaccination of cattle in the district concerned. Valuable assistance in this direction particularly with regard to the establishment of well equipped vaccination centres and the provision of manpower for the handling of the cattle, has already been rendered by a number of these organisations. Co-operative efforts of this kind have proved much more effective in dealing with the position than by visits to individual properties and similar action is urged in all districts where the vaccination of heifers from a number of properties is contemplated.

New Cereal Varieties in Australia.

I. THOMAS, Registrar of Cereal Varieties in Australia.

During 1946 two new wheat varieties Insignia and Pinnacle were registered. Both were sponsored by the Victorian Department of Agriculture and the particulars of the new varieties as supplied to the Registrar are as follows: —

Insignia.—An early maturing variety selected at the Mallee Research Station, Walpeup during the period 1933/37 from a cross between Ghurka and Ranee. The straw is yellow and strong and although relatively short it is a taller growing variety than Ghurka. It stands better than comparable early varieties. Insignia heads earlier than Ghurka or Ranee and is approximately similar in this respect to Regalia. The ear is of medium length, slightly tapering and although free threshing, does not shed. The outer glumes are red-brown and lightly awned whilst the grain is of medium size, yellow and equal to the better parent, Ranee in respect to flour strength.

Insignia is resistant to flag smut and less susceptible to rust than is Ranee. As the (Ghurka x Ranee) cross-bred M.6173 T14-2-1-1 Insignia was tested for five years at the Walpeup Research Station and other centres in the Mallee and gave consistently higher yields than Ranee 44, Regalia, Bencubbin, Pindar, Baldmin, Quadrat and Ghurka. It is therefore recommended by the Victorian Department of Agriculture for cultivation in the Mallee districts of that State.

Pinnacle.—Selected at the State Research Farm Werribee in 1934. Pinnacle is a midseason maturing variety slightly later than Pindar. The straw is yellow, short and strong but slightly taller than Ghurka. The ear is large and compact, free threshing but non-shedding. The outer glumes are red-brown and awned with large, yellow, shotty grain. The flour strength is superior to Pindar and Ranee and it is resistant to flag smut. As the Pindar selection W.603V it was tested for four years in replicated trials at Longerenong College, Salisbury, Kaniva and Charlton and gave higher yields than Quadrat and Ghurka. The Victorian Department of Agriculture recommends it for cultivation in the Wimmera District.

Produce and Market First Quality Eggs.

E. LOVEGROVE and S. FROOME.

THE yearly consumption of eggs per capita in Australia is so absurdly small that the poultry industry is forced to export a much larger percentage of its production than would be necessary if the public fully realised and justly estimated the value of eggs in the national diet. The Bureau of Agricultural Economics estimate that it cannot be expected that the consumption of eggs in Australia for the year ending June 30th 1947, will exceed 65 million dozen. With a population of approximately 7,411,000, it appears that each individual may consume 105 eggs during the year. The estimated consumption of eggs per head in the United States of America, for the same period, is 360 and during the war years it reached 390.

If each person in Australia would eat, on the average, only 3½ eggs a week the entire production would be consumed within the country and the poultry industry could expand to the limit of the visible overseas markets.

Under present conditions, however, the poultry industry can only maintain its position, or possibly expand, by the results of its overseas sales. The success of any marketing authority is bound up in the quality of the product it has to sell and it is axiomatic that the better the quality the easier the sale and the greater the demand for that particular product.

England is the principal overseas buyer of Australian eggs, and she requires and is willing to purchase at a reasonable price, many millions of dozens to feed her people, but she expects to receive a first-class article.

In order to ensure that wastage, due to rots, in eggs in shell shipped to the United Kingdom be reduced to a minimum this season the Department of Commerce has decided that washed eggs cannot be accepted for export. This decision

was reached after scientific research had definitely established that the terrific wastage was due to the entry of bacteria into the egg through wet cleaning. It may be thought that the banning of washed eggs for export would cause the accumulation of stocks so large that the limited disposal avenue of the local market would be glutted with a consequent collapse of prices. This contingency might arise if two limiting factors were not used to their utmost extent.

Australia is committed to export a large number of cases of eggs in shell and pulp to Britain this season and to fulfill her pledge every egg of export quality should be packed. To assist in carrying out this project the Department of Commerce has agreed to accept slightly soiled eggs provided they otherwise comply with the required standard. Consequently, eggs will be accepted for export which would have been rejected when the Department of Commerce insisted on a scrupulously clean shell. The second factor is perhaps, the more important; it is the adjustments that the poultry farmer will be required to make to produce a high percentage of clean first quality eggs which the future of his industry demands.

FACTORS INFLUENCING QUALITY BEFORE THE EGG IS LAID.

The quality of an egg cannot be improved after the egg is laid, therefore, any factor which may improve, or any condition which may have an adverse effect on the quality should receive special consideration. The original quality of the egg is mainly bound up in poultry breeding and attention to genetic factors which control the production of high quality eggs.

Shell Texture: The shell can be considered as a container, holding and preserving the quality of the contents; should the container be imperfect it is reasonable to suppose that the contents would quickly deteriorate. Therefore, the first consideration should be given to producing eggs with shells of good shape and texture. The detailed records of the Muresk Egg Laying Trials have demon strated that each hen lays eggs which are characteristically distinct to that particular hen for colour, shape, and shell texture. Should a hen continually lay eggs that are misshapen, ridged, excessively porous, chalky or thin shelled she should not be included in the breeding flock. These faults are, in the main, hereditary and can be remedied by selective breeding. Considerable loss occurs during all the stages of marketing due to weak shells, and owing to the deterioration of roads and railway rolling stock, during the war period, greater shell strength is needed to withstand the hazards of transportation. Chemical analysis disclose that the average shell contains 37.8 per cent. calcium and .2 per cent. phosphorus, and since eggs carry a relatively high percentage of calcium it is obvious that a hen will require more calcium as the rate of production increases. On the contrary, a deficiency of calcium in the diet will not materially affect the percentage composition of the shell but as the deficiency becomes more pronounced the shell tends to become thinner with ultimate cessation of egg production. For maximum egg production, the variation in calcium requirements of hens, under varying rates of production in the flock, are met by allowing the flock free access to oyster shell or high grade shell grit in addition to the calcium which is supplied in the diet. The common calcium supplements used are oyster flour and bonemeal; the former being approximately 38 per cent. calcium with only traces of other minerals. Oyster shells should not be used as a grit because of their high solubility. Steamed or sterilized bone meal is ordinarily considered as a phosphorus supplement, but it supplies calcium in the ratio of about 2 parts to one part of phosphorus. Therefore, when bone meal is added to a diet it supplies important amounts of calcium, but it is a more expensive product than oyster flour and for that reason is not an economical calcium supplement.

The concept of bone formation (Tyler, 1940), during the laying period particularly, is that the bone is formed of a skeletal lattice work of tri-calcium phosphate which is constant, but that the calcium within the cells formed by this lattice work is in the form of calcium carbonate. This storage is the means of providing the fluctuating amounts of calcium necessary for the formation of shells during active egg production, although there is a relationship between the two forms of calcium which prevents complete exhaustion of either supply.

In practice, it has been found that the average amount of oyster shell consumed per bird per year is approximately 3¼ lbs. Under usual conditions a mixture of 1/3 oyster shell and 2/3 good grade sea shell serves most purposes.

Infertile Eggs:

For market purposes infertile eggs should be produced; male birds should not be kept with the laying flock. One of the causes of egg spoilage is the development of embryos in eggs during the summer months when high temperatures prevail. When fertile eggs are subjected to temperatures within the incubation range, which begins at as low as 68°F. the germ will begin to develop. This development will take place slowly or more rapidly, depending on how favourable the temperature conditions may be, and may result in a relatively short time in development of the embryo to the point at which blood veins

Fig. 1.—Infertile egg at left, fertile egg at right after being kept four days at 100° F. (Photo. University of Missouri Res. Bull. 362.)

are formed and the egg is no longer edible. Recent research, by the University of Missouri, in stabilizing embryonic development shows that the immersion of fertile eggs in still water at temperatures between 136° to 140°F. for 10 to 15 minutes stopped embryonic development and the edible quality of the eggs was retained. Fig. 1 shows the difference between an infertile and a fertile egg held for 4 days at 100°F. and it is evident that under summer conditions only infertile eggs should be produced if good quality eggs are to be marketed.

The Effect of Breeding on Egg Quality:

Some important characteristics governing the commercial quality of eggs are hereditary. Some of these characteristics are egg weight, proportions of thick and thin albumen, and deterioration of egg white. Therefore, by selective breeding for each of these particular characteristics an improvement can be

made in egg quality, but it must be understood the points mentioned are only some of those which should be considered in a definite genetic breeding plan. Since the inception of the Muresk Egg Laying Trials, in 1927, breeders in Western Australia have realised the value of breeding for weight of egg and it is noticeable that the time required by pullets to lay eggs of 2 ozs. in weight has been reduced. It is generally conceded throughout the industry that it is necessary to breed from second season hens if strong and livable chicks are to be produced, and the practice of breeding from pullets is not recommended. When selecting a hen for the breeding pen it is of prime importance to have a record of her laying in her pullet year. Records of experimental work carried out at Muresk College show that many hens lay 2 oz. eggs in their second laying season, who in their pullet year produced a majority of underweight eggs. It is thus misleading to select a hen as a breeder on the weight of egg laid in the second laying period. Fig. 2 shows two typical examples of this type of layer.

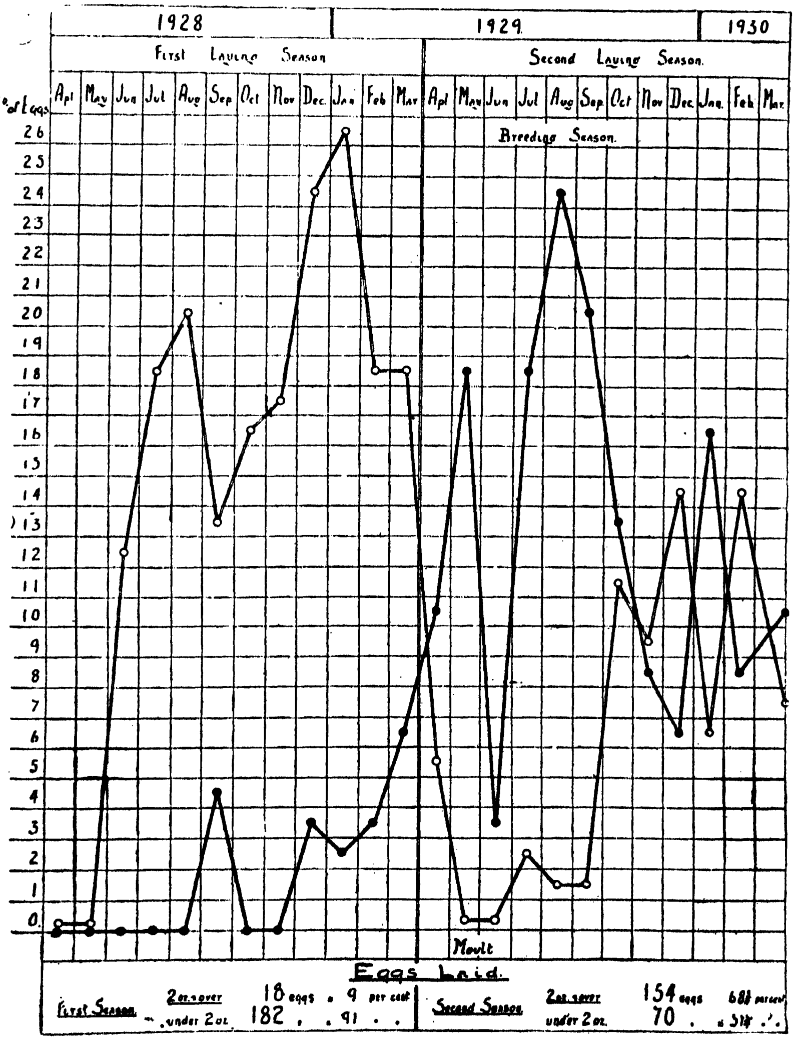

Fig. 2.—Weight of egg first and second seasons' laying.

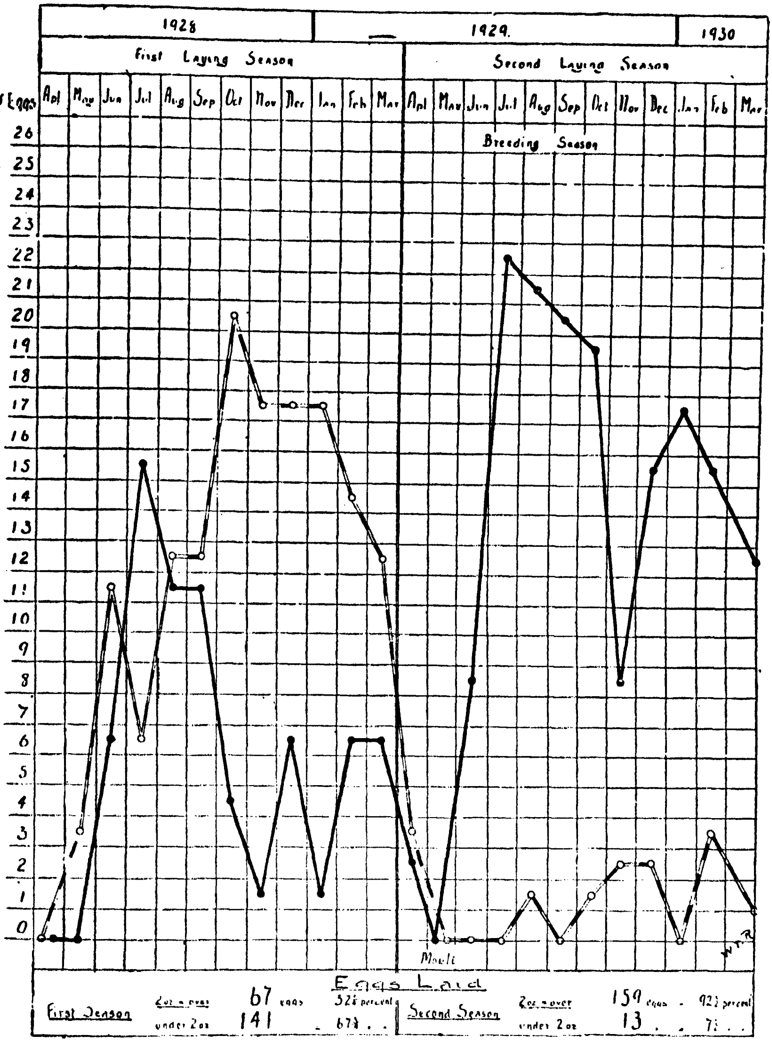

Fig. 2.—Weight of egg first and second seasons' laying.

A circular published by the United States Department of Agriculture states that "the percentage of thick albumen is an individual and hereditary characteristic. Data obtained indicates that by proper selection a strain of hens can be developed that will lay eggs having a high percentage of thick white.

The degrading of many eggs, when candled on the market floor to second quality is due to their high content of thin albumen. This type of egg which is known as a "watery white" when candled shows a thin white, a fast moving yolk, and generally an enlarged air cell due to the rapid evaporation of the thin albumen. To breed only from those birds who lay eggs containing a high proportion of thick albumen would require the single testing of each bird for

this factor, but this may not be possible for the commercial farmer with limited time at his disposal. However, he can markedly reduce the incidence of thin whites by candling every egg before it is placed in the incubator and reject any which show that peculiarity.

Fig. 3.—Eggs after cooking showing on left thick albumen and on right thin albumen.
(Photo. U.S.D.A. Circular 583.)

The results of other research work, undertaken by the same authority, indicates that the rate of deterioration of thick white appears to be hereditary. Although there was no significant difference when fresh, the eggs produced by different lines of White Leghorns differed materially after they were held. Fresh eggs from two lines had exactly the same percentage of thick white, but after these eggs had been held at approximately 78°F. for 21 days under the same environmental conditions, the percentage of thick white for those in one line was 32 per cent. and for those in the other line 13 per cent. This work indicated that the rate of deterioration of thick white depends on hereditary factors as well as on conditions under which the eggs are kept.

Research work undertaken by the Ministry of Agriculture and Fisheries, England, and by the University of Illinois, U.S.A., indicate that meat spots and blood spots are pathological conditions associated with the individual hen rather than the feeding of high proportions of protein in the diet. The possibility of aggravating these conditions by the inclusion of high proportions of animal protein in the diet is not, however, ruled out. Certain families and individuals, as well as certain strains, are much more disposed to the production of blood spots than others. Blood spots can be greatly increased or decreased by selection within a blood spot strain.

The Effect of Feeding on Egg Quality:

Widely speaking, the feeding practices in operation on commercial poultry farms in Western Australia are such that good quality eggs should be produced under normal conditions, but a few points may be of interest.

The public prefer a richly coloured yolk; therefore, from a marketing point of view the colour of the yolk is extremely important to the commercial egg producer, for he must satisfy this preference if he wishes to create a demand for his product. Yolk colour is not a breed characteristic, but is largely determined by the conditions of feeding.

Oats, wheat, milk, meatmeal and their by-products give rise to pale yellow coloured yolks, but maize, green food, generally, and lucerne meal produce richly coloured yolks. Feeding cabbage or clover in abundance gives an orange-red colour to yolks. Linseed meal is said to give rise to yolks of a greenish colour, and the abundant feeding of rape will produce yolks of an olive tint.

If there is more than 5 per cent. of cotton seed meal in the diet, the yolks tend to become mottled if the eggs are stored for some months; also the whites may acquire a pink tinge.

The use of the last three foods in a laying ration should be restricted.

Apart from the influences of breeding, as noted above, nutrition is a factor in the production of blood spots in eggs. When birds are allowed fresh green feed daily there is a reduction of the incidence of blood and meat spots.

As regards size or weight of egg, although genetic breeding must be practised to maintain this factor, it is also necessary that the diet should contain 15 to 16 per cent. of protein and about 20 per cent. of this protein should be derived from animal sources. In general, if the diet contains some dried skim milk or dried buttermilk the eggs tend to be slightly larger than if these feedstuffs are not used.

As the public are now vitamin conscious, it is worthy of note that the vitamin content of eggs may be affected by diet. The content of vitamins, A, B1, G and D in the egg can be increased by feeding diets that contain relatively large quantities of these vitamins. The following are the better sources of:—

Vitamin A.—Cod-liver oil, certain shark oils, and the carotenoids in green plants are converted into Vitamin A when fed to poultry.

Vitamin B1.—Dried yeast, liver, bran and pollard.

Vitamin G.—Dried whey, dried buttermilk, dried skim milk, fish meal, and in green plants, particularly lucerne.

Vitamin D.—Cod-liver oil and it is developed in the body of the bird by exposure to sunlight.

Conditions influencing quality after the egg is laid:

Since no methods are known of improving the initial quality of eggs after they are laid, or of restoring quality already lost, it is of the utmost importance that the original quality should be preserved as far as possible. Research work by Dr. E. M. Funk of the University of Missouri, on the thermo-stabilization of quality in shell eggs, has demonstrated that the normal breakdown of thick albumen can be greatly retarded, and the vitelline membrane surrounding the yolk can be made to retain its strength for a longer period. The treatment consists of applying heat at a relatively low temperature (about 140°F.) for a period of approximately 10 minutes. At some future date it may be possible to erect plants at the markets to stabilize the quality in shell eggs by this treatment but it will still be the responsibility of the poultry farmer to deliver the eggs to the treatment plants in the highest quality condition. Quality declines with the age of the egg, the rate of decline being dependent upon environment conditions such as temperature and humidity, whether or not the egg becomes contaminated, methods of handling, and other factors. It would assist to retain quality if all persons handling eggs would remember that eggs are a food and although the edible portion is encased in a shell, they should be handled with care and with clean hands.

From an economic point of view the second quality egg is an actual and substantial loss to the poultry farmer. The following table shows the loss to producers on second quality eggs received under control in W.A. in the last 2 years:—

——	30th June, 1945.	30th June, 1946.
Number of 2nd quality eggs (Hen)	489,743 doz.	508,359 doz.
Percentage of total receivals	10·29%	9·82%
Number of 2nd quality eggs (Medium)	137,993 doz.	86,521 doz.
Percentage of total receivals	2·90%	1·67%
Total number of 2nd quality eggs	627,736 doz.	594,880 doz.
Percentage of total receivals	13·19%	11·49%
Average difference in price between 1st and 2nd quality	4d. per doz.	4d. per doz.
Actual loss to producers	£10,462	£9,914

This shows a loss to the producers of £20,376 in two years, most of which could have been saved by correct methods of production and marketing.

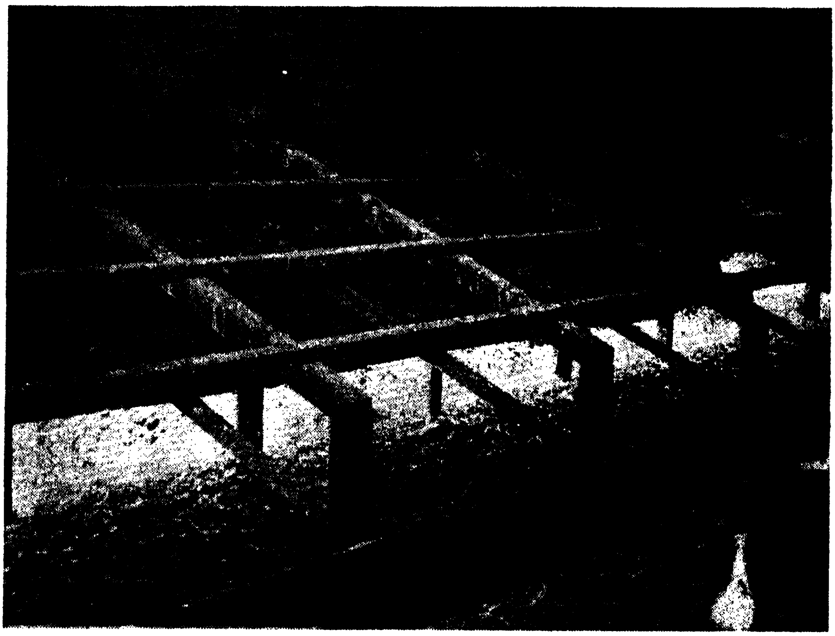

Fig. 4.—Wire netting of perches to prevent fowls gaining access to night droppings. Note wire netting extends down front as well as immediately beneath.
(Photo. Govt. Printer, Property M. Stocker.)

Environmental conditions in the laying shed.

No apology is offered for reiterating and stressing the sanitary conditions which should be present in all laying sheds. The salient points are:—

(a) Provide ample floor space in the shed, 3 to 4 square feet for each laying bird.

(b) Provide a concrete floor and keep it covered with clean litter.

(c) Fasten wire netting to the underside of the perches to prevent birds from having access to the droppings. (Fig. 4.)

(d) Clean out the droppings at regular intervals and, when the litter becomes dirty, clean the shed thoroughly and provide new, clean litter.

(e) Keep the nests filled with clean nesting material. White shavings, white sawdust, clean dry sand, and shellgrit have given most satisfaction as nesting material.

(f) In wet weather, when the birds will have muddy feet, keep the laying flock confined to the shed until midday. The majority of the eggs will have been laid by that time, but the eggs should be gathered at least twice in that period. The type of laying shed recommended by the Department of Agriculture is designed for this purpose.

(g) Cover the nests at night to prevent the hens from roosting in the nests.

(h) Remove all broody hens from the laying shed immediately they become broody.

Gathering the eggs:

Gather eggs at least three times daily; twice in the morning and once in the afternon.

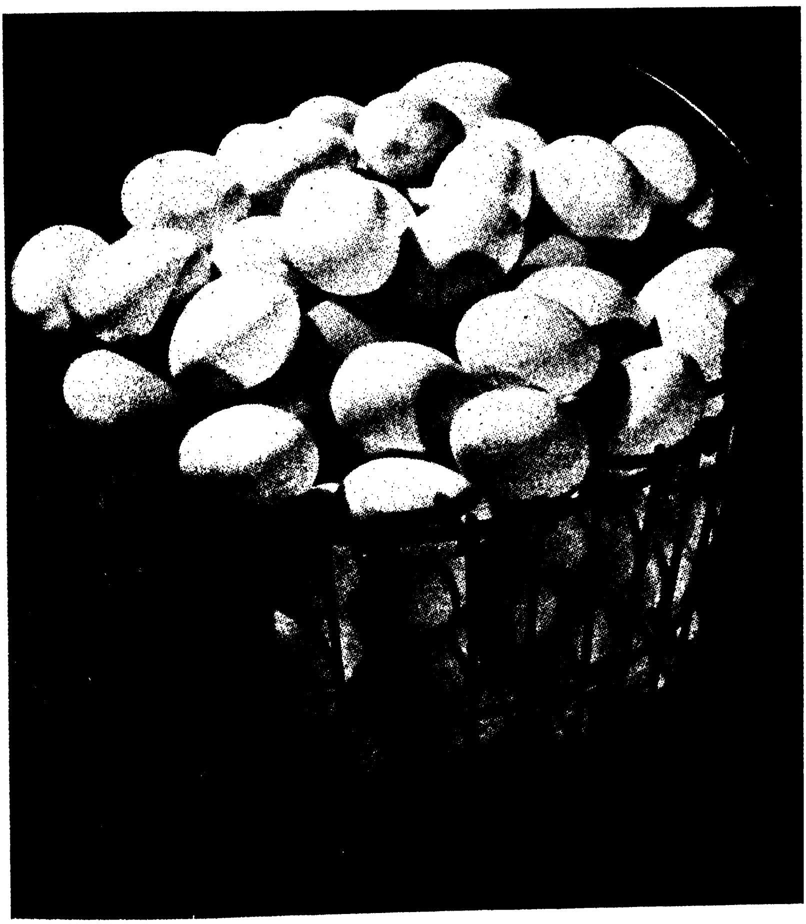

Fig. 5.—Wire egg baskets are invaluable for gathering eggs on the farm. (Photo. University of North Carolina Ext. Circ. 275.)

Procure some wire baskets, as shown in Fig. 5 and gather the eggs in them. Wire baskets are superior to buckets for they allow the eggs to cool down quickly. In order to retain the interior quality and flavour in the egg the animal heat must be removed as quickly as possible.

Handling quality eggs on the farm:

From the time the eggs are gathered until they reach the market is a period when much damage can be done to quality if a correct routine is not followed.

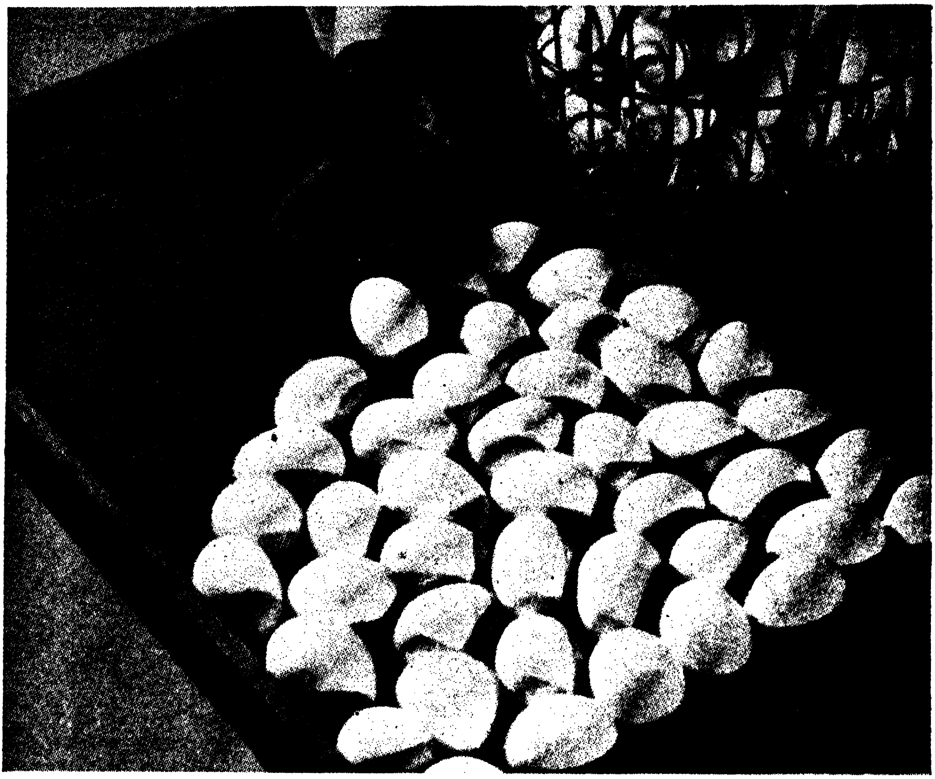

Fig. 6.—Wire egg trays for fitting into cooler. These are invaluable for holding eggs prior to packing for market.
(Photo. University of North Carolina Ext. Circ. 275.)

Cooling:

Although a wire basket may have been used to gather the eggs and allow of a certain amount of cooling, it is preferable to spread them on wire bottom trays to ensure rapid cooling. Fig. 6 shows a type of tray that is suitable and several of these could be fitted into a cooler known in Western Australia as a "Coolgardie Cooler." Eggs should never be packed in cases the same day that they are laid unless they have been thoroughly cooled. It is generally recognised that the quality of an egg is best when laid but its temperature is that of the hen, 104° to 107°F., and if it remains too long at near that temperature the quality of the white begins to deteriorate. The optimum range of temperature for holding eggs on the farm is 40° to 55°F., but they should not be cooled to a temperature lower than 40°F. because if they are later subjected to a comparatively high

temperature in transportation, condensed moisture may form on the shells. Research work has demonstrated that, if eggs are held on the farm at the suggested temperature, the differences in albumen quality between eggs one day old and five days old is rather small and not of much practical importance.

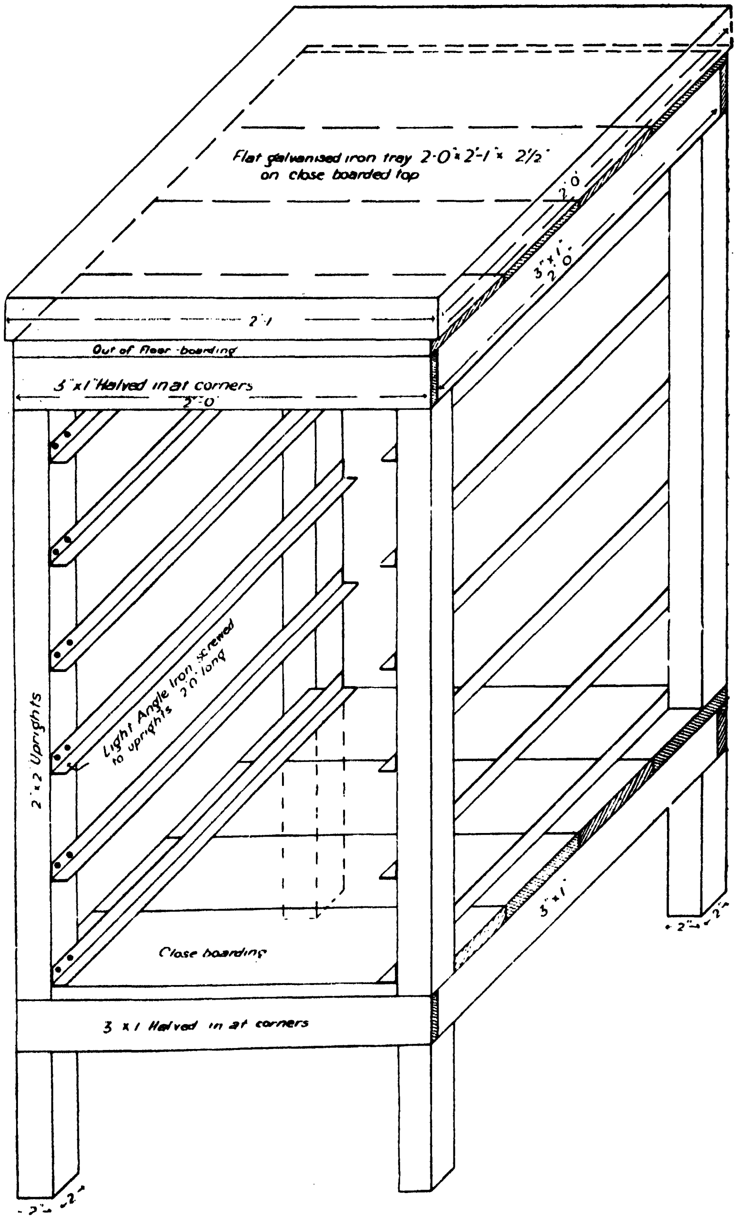

Fig. 7. —EGG COOLER— suggested design

(NOT TO SCALE)

An inexpensive egg cooling rack can be constructed on the lines of the "Coolgardie Cooler," which has proved successful in South Australia. Fig. 7 shows a suggested design which can be easily constructed on the farm. Owing to the recent advance in electric cooling, it is likely that refrigerators designed to meet the special needs of the poultry farmer may soon become available, but unprotected eggs lose moisture rapidly in an ordinary family refrigerator.

Moisture:

To retain good quality in the eggs moisture is just as necessary as keeping them cool, especially in a warm, dry climate. An atmosphere which is cool and has a fairly high relative humidity protects the contents of the egg from evaporation and consequent shrinkage, and prevents the rapid enlargement of the air cell. However, too high humidity and stagnant air are likely to result in the development of mould on the eggs, quickly making them inedible. When eggs are candled the depth of the air cell is considered one of the indicators of age, but this is only a true sign if the conditions under which they have been held are known. If eggs are held, during warm weather, in a room where a current of dry warm air passes over them the evaporation of the contents will be so great that the air cell depth would indicate an age of at least 14 days when in reality it may only be of two days. The air cell depth coupled with the fact that the white would have commenced to lose its quality would cause these eggs to be degraded to second quality.

Summing up the internal changes that may take place before the eggs reach the market: The air space increases in size because of loss of moisture by evaporation; the weight decreases; the white tends to become thin; and the yolk membrane weakens. General conditions which are necessary to retard these changes suggest that eggs should be cooled quickly and stored in a cool, fairly moist, well ventilated place, where the temperature does not vary greatly, and where there are no objectionable odours such as kerosene, onions, etc.

Packing, handling and transport:

To assist in preserving egg quality it is advisable, during hot weather, to precool the cases and fillers before eggs are placed in them. When cases and fillers have been stored in a dry, warm storeroom the moisture they originally contained has evaporated and they are in a condition to absorb moisture from the eggs as soon as they are packed. Two or three days before the cases are to be used they should be placed in a cool, moist room, preferably above a concrete floor that has been sprinkled with water or on the slatted top of a large shallow sand box; the sand being kept wet by pouring a bucket of cold water over it each day.

It is now universally known that eggs should be packed with the large ends up to preserve the position of the air cell but it is not realised the damage that can be done to the air cell by careless handling in the short journey from the nest to the packing room and on to the market.

When eggs are subjected to jars or shocks in handling and transport, there is a tendency for the air cell to become "tremulous," that is, the shell membranes become separated over a larger area than that occupied by the air cell itself, and this permits a tremulous movement of the air cell as the position of the egg is shifted before the light. In some instances, the air cell may be "free" in the egg, permitting it to assume the uppermost position in the shell no matter how the egg is turned. This is due to the rupture of the inner shell membrane leaving the air free to move to a space over the contents of the egg.

However ideal the holding conditions on the farm it is still necessary to market eggs frequently; for although the quality may not deteriorate to any extent, it cannot improve. Therefore, eggs should be sent to market at least twice a week and more frequent deliveries are desirable.

Where there are no special facilities for transporting eggs to market, careful hauling will repay the producer. Precautions against unnecessary jolting should be taken and eggs should be covered to protect them from the warm sun. To maintain the original quality as long as possible in so perishable a product requires great precaution in caring for eggs on the farm and through all the steps to bring them to the consumer, but with correct procedure a first quality egg can be delivered to the consumer.

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The Soybean.

ITS POSSIBILITIES IN W.A.

By H. G. ELLIOTT, Agrostologist.

THE world's production of soybean is probably in excess of 7,000,000 tons annually—Manchuria, the largest producer, is followed by China, Japan and the United States of America; very little at present is known with reference to the production in Russia. In Australia the acreage grown is as yet only small and up to the present time has been mainly experimental.

ECONOMIC POSITION.

The Manchurian production up to the time of the last war was still the most important in the world and controlled the export market for soybeans. China, United States, Chosen, Japan and Netherlands East Indies are producers of this bean but mainly for their own use. Bulgaria, Czechoslovakia and Russia are also producers but in comparatively small quantities.

Of the total Manchurian production prewar—⅓rd was exported to each of Europe and Japan and ⅓rd was required for own use.

Practically all of the European States were importers of this oil and the U.S.A. produces only enough for their own requirements. In 1936 America produced 30,000,000 bushels of which 20,000,000 bushels were used for crushing.

SOYBEAN OIL.

The yellow seeded varieties of this bean are the most suitable for oil production, whereas the Black and Brown seed types are suitable for silage, hay and forage but undesirable for crushing for oil. For the extraction of oil there are three methods used, i.e.:—

(1) The expeller method—commonly used in U.S.A.
(2) Hydraulic Press method—sometimes used in U.S.A.
(3) Solvent-Extraction method—used in Europe.

The oil content of the beans is between 18-19 per cent. on a natural moisture basis, but there are varieties known which contain up to 23 per cent. of oil. In America the average yield by the crushing methods is 14 per cent. or 8.4 lbs. of oil per bushel, of 60 lbs. of seed. The yield of cake is 80 per cent. or 48 lbs. per bushel; the balance of 6 per cent. or 3.6 lbs. represents waste. One lb. of oil is valued at from 2-5 times the value of 1 lb. of cake, consequently, the best price is obtained from 1 bushel of beans when the most efficient method of extraction of oil is used. Of the methods of extraction used the solvent method leaves 5 per cent. of the oil remaining in the cake and the expeller and press methods leave 21 per cent. to 22 per cent. of the oil in the cake.

VALUE AND USES OF SOYBEANS.

Value of Soybeans:

Soybean
- PLANTS
  - Green Manure
  - Forage
    - Hay
    - Silage
    - Soilage
  - Pasture
- BEANS
  - MEAL — *Substitute:*
    - Celluloid
    - Stock feed
    - Fertiliser
    - Human food
      - Breakfast foods
      - Diabetic foods
      - Flour
        - Bread
        - Cakes
        - Milk
      - Infant foods
      - Macaroni
      - Crackers
      - Soy milk
      - Bean curd
      - Soy sauce
      - Bean powder
    - Glue
    - Vegetable casein
    - Waterpaints
  - OIL
    - Glycerine
    - Enamels
    - Food products
      - Butter substitutes
      - Lard substitutes
      - Edible oils
      - Salad oils
    - Varnish
    - Waterproof goods
    - Linoleum
    - Paints
    - Soap stock
      - Hard soaps
      - Soft soaps
    - Celluloid
    - Rubber substitutes
    - Printing inks
    - Lighting
    - Lubricating
    - Core binder
    - Candles
    - Lecithin
  - GREEN BEANS
    - Green vegetables
    - Canned vegetables
    - Salads
  -
    - Stock feed
      - Sheep
      - Hogs
      - Cattle
      - Poultry
    - Soy sauce
    - Boiled beans
  - DRIED BEANS
    - Baked beans
    - Soups
    - Coffee substitute
    - Vegetable milk
      - Bean curd
        - Fresh
        - Dried
        - Smoked
        - Fermented
      - Condensed
      - Soy milk
      - Fresh soy milk
      - Confections
      - Soy casein
        - Textile dressing
        - Waterproofing paper
        - Size paints
      - Soy milk powder

USES OF OIL.

During 1931-34 the most important outlet for the oil in America was the paint and drying oil industry. During 1936, 81 per cent. of the factory consumption of the oil was in food products and only 9 per cent. in the drying oil industry. In spite of this (81 per cent. Soybean oil used in food products), Cottonseed oil still dominates the edible oil field as 52 per cent. of the primary fats and oil in used food products was Cottonseed and only 6 per cent. was Soybean.

With reference to drying oils in America, 53 per cent. was Linseed oil and 3 per cent. was Soybean oil. Soybean oil is a semi-drying oil with an Iodine No. 134 and Linseed oil is a drying oil with an Iodine No. 188.

The Soybean oil must be used in combination with some other oil, paints made with Soybean oil do not yellow with age and consequently it is used in pale coloured enamels and paints for interior use. Other than this, however, its use is limited to 10-50 per cent. of the oil used.

In food products Soybean oil has a tendency to acquire an unpleasant flavour on ageing and generally is used only in low grade products which have a quick turnover. Thus at best it is only a substitute oil with a limited market.

ORIGIN.

For many thousand years the soybean has been grown in Manchuria where it is a staple crop and provides the bulk of the food of the native population. However, the export value of the bean has been, and still is, the main source of revenue of the country. China is also a large grower of the bean and these two countries in pre-war days produced about 80 per cent. of the soybeans grown throughout the world. In recent years Japan and Korea have increased the acreage sown to this crop.

Soybean, showing flowering branch, flower, leaves and pods.

The United States of America, prior to the war, grew over 500,000 tons of soybeans. In the United Kingdom, prior to the war, certain selected varieties were produced which were suitable for growing in their climatic conditions and an increase in acreage grown is still occurring.

USES IN WESTERN AUSTRALIA.

As has been shown this bean has a wide range of uses but at the present time it is doubtful if it could compete as a fodder with other summer grown ones in this State. The selection and breeding of varieties suitable to our particular climatic conditions may eventually place this bean in the position whereby it can be grown profitably.

The dried bean which is rich in protein and oil, is suitable for canning, also for the preparation of diabetic and other human foods but finds its greatest use in industry where it is a valuable source of oil for the manufacture of foods, paint, and many other purposes while the residue is utilised for human and stock foods and for the manufacture of plastics, glues and paints.

NAME AND ORIGIN.

This plant has been given numerous names, several of which appear to be in common use; thus it is known as *Glycine max, Glycine hispida, Soja max* and *Soja hispida*. W. Reide (Germany) names it *Soja hispida* and points to *Soja ussuriensis,* a wild form growing naturally in Manchuria, as the parent form. He distinguishes two groups of species of the genus *Soja.*

(1) *The Tropical Group.—Soja javanica, S. Toinentosa* and *S. pentaphylla* found growing in Java, the Phillipine Islands, India, etc.

(2) *The Temperate Group.—Soja ussuriensis,* a wild specie; *Soja gracilis,* a semi-cultivated specie; *Soja hispida,* a cultivated specie.

Soja ussuriensis grows wild in north-east Manchuria; the hill country between Ussuri and Sungari is the home and principal area of distribution of this parent species, which is found in many parts of Manchuria, Japan, China and Korea.

DESCRIPTION.

The soybean is an erect, bushy, leafy annual which branches profusely from nodes at the base of the stem. When it is crowded or grown too closely in the rows very little branching occurs. The leaves are trifoliate, occasionally having four or five leaflets. The first leaves above the cotyledons are simple and opposite. Compound leaves arise at the nodes and alternate. The leaves of varieties which have yellow cotyledons turn yellow before falling, the leaves of other types fall off without turning yellow.

The flowers are borne in racemes or peduncles in the nodes. The flowers appear first at the base of the main stem and then progressively towards the tip. The period of flowering does not usually last longer than 3 weeks. The pods contain 1-4 seeds and this variation occurs within individual varieties. The plants are normally self fertile. Pollination occurs a little before, or as soon as the flowers open. A small amount of natural crossing does occur, but where this has been investigated it has been found to be less than 1 per cent. Natural crossing is believed to be due to Thrips tobacci and may be due in some instances to honey bees.

CLIMATE.

The soybean thrives best in a monsoonal climate with great summer warmth, heavy summer rainfall and a high degree of humidity. The beans are susceptible to frost and must be grown in regions which are free from frost during the growing season. If drying winds occur during the flowering period, poor seed setting and a high proportion of bladder pods occur.

Generally speaking climatic conditions suitable for the growing of maize for seed are required for these beans.

In this State it is considered that areas sheltered from hot, dry winds and where irrigation can be practised if the land is not retentive of summer moisture, should give good results. Many of our coastal swamps would probably be suitable. Experiments with many varieties have been tried and still are being tried in various localities in the South-West, and also at the Ord River and Carnarvon.

SOILS.

Soybeans can be grown on many types of soil, such as sandy, loamy and clayey types. They prefer alluvial soils and loams. Well drained soils are an advantage, although the plant is able to withstand a considerable amount of soil moisture for short periods. These beans succeed better on acid soils than is the case with lucerne.

CULTIVATION.

The land should be plowed at least 4-5 inches deep with a mouldboard plow in the early spring months, and left in fallow for 2-3 weeks, when the land should be then worked down by means of cultivators and harrows. The final preparation consists of obtaining a fine surface layer with a well compacted subsoil.

Soybeans drilled in rows two feet apart to permit tillage.
(Photo. Illinois Agricultural Experiment Station, Bull. 453.)

FERTILISER.

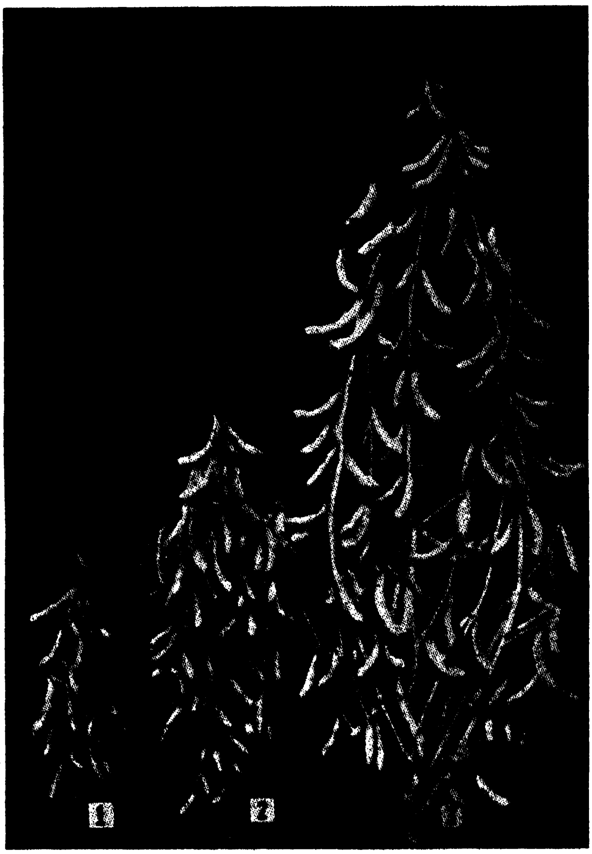
Two cwts. of superphosphate per acre is considered suitable for this State. The fertiliser should be thoroughly incorporated in the soil before the seed is sown as the seed is readily damaged by contact with fertiliser; apart from the damage to the seed there is a possibility of the fertiliser injuring the nitrogen fixing bacteria, which is applied to the seed prior to planting.

INOCULATION.

Soybeans are legumes and as such require the presence of nitrogen fixing bacteria on their roots before they reach maximum development. A strain of bacteria (Rhizobium) suitable for this bean is available at the Department of Agriculture. The inoculum is placed on the seed, prior to planting. Full particulars as to how to inoculate the seed are supplied with the bacteria when obtained.

SOWING.

The seed is sown as soon as the land is sufficiently prepared and when the danger of frost is past. The seeds are sown at a depth of 1 inch: depths greater than 2 inches are harmful. A loosening of the soil crust by light harrowing before the plants come through and after the germinating rains, is an advantage. The beans should be planted in rows 2½ to 3 feet apart with 4-6 inches between plants. In this case, five to twelve pounds of seed are required per acre, according to the size of the seed and the variety sown. Sowing may be done with a maize drill with a special plate or by means of a wheat drill by blocking up all but a few of the tubes.



Differences between varieties in growth habit.
No. 1 is an early maturing type with a low yield of both seed and hay.
No. 2 is a typical bunch variety with a low hay but a fairly high seed yield.
No. 3 is a dual purpose type with a seed and hay yield.
(Union of South Africa, Bull. No. 240.)

INTERCULTIVATION.

Two or three cultivations are usually given between the rows during the growing season. This is done to control weeds and to allow moisture to soak in if rains occur.

HARVESTING.

The beans may be grown for silage hay or seed.

(1) *Silage.*—Cut when seed is well developed but before any of the leaves fall away. Silage produced from soybeans is too rich in protein and fats and is not relished by stock. Soybeans make more palatable silage when mixed with twice as much maize. It gives a flavour and odour to the milk.

(2) *Hay.*—Soybeans are cut for hay when the pods are well formed. If left later the stems harden, the leaves fall and the percentage of protein decreases. Cutting is done in the morning after the dew has disappeared. When it is well wilted it is raked into windrows and haycocks. The development of the pod is found to be the most reliable guide of the time of harvesting.

(3) *Seed.*—Non-shattering varieties may be left much longer than shattering varieties. They are usually harvested when most of the leaves have fallen and when the pods are about one quarter filled. The development of the brown colour in the pods serves as a good index of the time of harvesting.

Harvesting should be done on a damp cloudy day or when the dew is on the plants to avoid shattering. The seeds heat readily and should be thoroughly dried before stacking.

VARIETIES.

A large number of varieties of soybeans are known which vary in the length of their period of maturity, and experimentation is necessary to define the varieties most suitable to various districts. However, the Council for Scientific and Industrial Research have obtained best results with Charlee, Haberlandt, Creole and Georgian varieties in Queensland, whilst Manchu Yellow and Haberlandt, have been grown with some success in Western Australia and yields as high as 35 bushels per acre have been obtained experimentally.

SUMMARY OF SOYBEAN TRIALS IN W.A.

The Department of Agriculture in this State has for many years introduced numerous varieties of soybeans for trial at various centres over a wide range of soil and climatic conditions, from as far North as the Ord River in the Kimberleys to Albany on the South coast, and the results to date have not been completely successful.

The early trials did not meet with much success because of three main factors—

1. Inability to obtain good inoculation on plants as a suitable strain of bacteria for inoculation of seed was not available.

2. Suitable strains and varieties of soybeans were not available as those tried were too long in maturing.

3. Low germination of seed imported for trial.

In recent years better results have been obtained as—

1. Suitable bacteria for inoculation is available.

2. A larger range of earlier maturing varieties has been obtained for trial in the South-West. Time of maturity is not a major factor in the North.

Of the varieties grown in the South-West, Manchu Yellow, Haberlandt, Arysoy, Easy Cook, Harrow Mammoth Brown, Kenway and Q1463 have all given reasonable results and yield up to 30 bushels per acre of seed have been obtained from them. Seasonal conditions at the time of flowering appear to play an important part on yield as hot dry weather with high wind at flowering time appears to cause the non-setting of the seed but the production of bladder pods.

At the present time a large range of soybean varieties is under trial at various centres.

SOYBEAN VARIETIES—AMERICAN.

Variety	Average No. of days to mature.	Yield bus./acre.	Seed Colour.
Ito San	89	29.5	Y
Ohio 9100	89		
S.P.I. 36916	89		
Manchu	91		Y
Black Eyebrow	91	33.4	Y
S.P.I. 36901	91		
S.P.I. 36647	91		
Elton	92	34.3	Y
S.P.I. 36576 (Aksarben)	96		Y
S.P.I. 30745 (White Eyebrow)	99		Y
Check (Wilson 89)	102	31.4	Y
Ohio 9035 (Hamilton)	102	37.3	Y
Ohio 7490	102	12	
Ohio 9016	103		
Wilson	104	33.9	Y
Ebony	104	18.7	Y
Medium Green	105	34	
Habaro	106	13.6	Y
Haberlandt	109	15.6	Y
Mikado	109		Y
Royal	109	22.9	Y
Peking Sel 1-21-8	110	30	Y
1-21-5	110		Y
1-21-7	110	32	Y
S.P.I. 28051	110		
Sherwood	110	26.2	Y
Virginia	111	31.0	Y
Peking	111		Y
Peking Sel 1-21-3	111		
Shingto	111	46.6	Y
Chestnut	111	31.1	Y
Early Yellow	112	15.1	
American Coffee Berry	112	12.7	
Early Black	112	21.9	
Peking Sel 1-21-3	113	37.3	
Sable	115		
Wisconsin Black	115	21.0	
Medium Early Yellow	115	18.9	

SOYBEAN VARIETIES—AMERICAN—*continued.*

Variety	Average No. of days to mature.	Yield bus./acre.	Seed Colour.
Medium Early Brown	115	16.6	
Medium Early Black	115	12.0	
Ohio 7406	116	20.0	
Mongol	116	24.0	
Taha	117	46.6	
Jet	117	32.4	
Haberlandt	118	15.6	
Chernie	119	13.7	
Nuttall	119	14.2	
Ohio 7476	122	16.0	
Medium Green	124	15.0	
Amherst	134	15.9	
Meyer	134	14.8	
Cloud	125	13.4	

CANADIAN SOYBEAN VARIETIES.

Variety	Average No. of days to mature.	Yield bus./acre.	Seed Colour.
St. Anne's No. 92	108	21.68	
Early Brown	109	25.9	Y
Mandarin	113	29.53	Y
Yellow 210	117	30.87	
Yellow 17	118	31.22	
Chinaton Echo	117	27.64	
Italian	119	30.19	
O.A.C. No. 211	121	33.78	
O.A.C. No. 81	117	28.71	
Summerland	119	23.94	
Black (China)	117	25.84	
Early Korean	123	35.48	
Green	122	34.25	Y
Manchu	123	34.88	Y
Black Eyebrow	122	34.96	Y
Ito San	123	29.60	Y
Golden	125	35.48	
A.K.	126	37.44	Y

Varieties grown experimentally in New Zealand and having an average yield of 23 bushels.—Early Yellow, O.A.C., Black Ontario, Manchu (Hudson), Manchu (Ottawa), Cayuga.

SOME EDIBLE VARIETIES OF SOYBEANS.

As Green Vegetable.—Agate, Hahto, Easycook, Rokusen, Funk Delicious, Kura, Aoda, Bansii, Shiro, Hokkaido, Chusei, Higan, Janro, Willoni, Nanda, Jogun.

Cooking Dried Beans.—Easycook, Chusei, Rokusen, Jogun, Hokkaido, Janro.

Fertilisers for Lettuces at York.

L. T. JONES AND J. P. ECKERSLEY.

SUMMARY.

WARTIME shortages of blood and bone manure have resulted in fertiliser difficulties with vegetable crops and particularly with the lettuce crop at York. As a result an experiment was carried out with this crop on a red-brown earth typical of the York gum and jam country at York, to demonstrate the satisfactory replacement of blood and bone manure with mineral fertilisers. The results and recommendations may be summarised as follows:—

(1) The primary fertiliser need for lettuces under these conditions was nitrogen.

(2) When using blood and bone manure only as a source of nitrogen, at least a ton per acre had to be used for satisfactory yields.

(3) All six mineral ("artificial") fertiliser treatments were as good or even better than one ton of blood and bone manure per acre.

(4) Potash had no beneficial effect in this experiment.

(5) With the autumn planted lettuce crop at York the "artificial" fertilisers could be applied in one application about one week after transplanting. It was not necessary to split the fertiliser into three applications, as is often advisable on sand country where leaching is severe.

(6) Two cwts. per acre of superphosphate plus three cwts. per acre of sulphate of ammonia (costing £3 10s. per acre) gave as good, or even better, results than one ton of blood and bone per acre (which costs £10 or more an acre and furthermore is now in very short supply).

(7) In this experimental lettuce crop, no evidence of fertiliser injury was observed, even when mineral fertilisers were used at the rate of 15 cwts. per acre. There was evidence that growers were confusing plant disease with fertiliser injury.

(8) The experiment indicated that, for lettuces, under these conditions, low rates only of mineral fertilisers were needed when chiefly nitrogenous fertilisers were used. The likelihood of fertiliser injury would be reduced by adopting a similar fertiliser practice.

(9) Blood and bone is a relatively inefficient form of nitrogenous fertiliser when compared with sulphate of ammonia under these conditions. The nitrogen content of one ton of blood and bone manure is approximately equivalent to six cwts. of sulphate of ammonia, yet an application of only three cwts. per acre of sulphate of ammonia gave equal or even better results than one ton of blood and bone manure.

It is apparent that under the continued shortage of the popular blood and bone manure the principles of the alternative use of the mineral, or so-called artificial fertilisers must receive increased consideration by the growers if vegetable production is to be increased or even maintained.

INTRODUCTION.

Complaints were received that mineral fertilisers could not be substituted for the generally used blood and bone manure and, in consequence, shortages in the supply of blood and bone manure were seriously limiting the area that could be cropped in the York market gardens.

In February, 1946, the authors paid a visit to the York market gardens and discussed with certain growers their fertiliser problems. Their main problem appeared to be the lettuce crop. They stated unanimously that lettuce could not be grown successfully unless a ton of blood and bone to the acre was used and that potato manure was no substitute for blood and bone manure for the lettuce crop. It should be noted that the blood and bone manure position had reached such a low ebb that the ration at the time was three cwt. per acre. With their other main crops growers were using potato manure to some extent.

The manuring of the lettuce crop, therefore, seemed to present greatest difficulties and the questions which required to be answered were—

(1) Can lettuces be grown successfully unless a ton of blood and bone manure to the acre is used?

(2) Is potato manure at 15 cwts. per acre a suitable fertiliser for the lettuce crop?

Growers reported the following effects of potato manure on the lettuce crop:—

(a) Although initially there is an obvious stimulation, growth later falls off and the lettuces "finish" poorly.

(b) Potato manure at 15 cwts. per acre is liable to cause fertiliser injury.

It was considered advisable to undertake demonstrations with mineral fertilisers to show that other fertilisers, when properly applied, could be satisfactorily substituted for blood and bone manure.

Previously many similar fertiliser experiments embracing six different vegetable crops had been completed in the metropolitan area, demonstrating that blood and bone manure could be replaced by artificial fertilisers when a properly balanced fertiliser mixture is used appropriate to the type of crop and the particular soil and climatic conditions.

SYSTEM OF MARKET GARDENING PRACTISED AT YORK.

York is situated 60 miles from Perth in a mixed farming district with cereals, sheep and pasture predominating. The York market garden produce has earned a place for itself on the Perth market because it can supply high quality vegetables at a time when the metropolitan supplies are deteriorating in quality. The produce is carted by motor transport to the Perth markets. The total annual rainfall is 17½ inches, of which 14½ inches falls in the winter months of May to October, inclusive. During the summer months the gardeners draw on the Goldfields Water Scheme to water their crops either by sprinkler irrigation or watering cans. They find it economic to pay for the scheme water at the rate of 1s. 6d. per 1,000 gallons. An area of up to 200 acres is cropped annually and about 30 growers are operating.

The gardens are situated mainly on the red-brown soils carrying York gum and jam. The soil generally has red-brown sandy loam to a foot deep, passing into red-brown clay.

What has been accomplished in this district indicates that practically any wheatbelt farmer can be a successful home gardener provided he has the requisite knowledge and a sufficient supply of good water.

THE FERTILISER PRINCIPLES INVOLVED.

It is necessary in the discussion of a fertiliser experiment of this nature to clearly understand the principles of manuring, so that the results will not be misinterpreted and applied to cases where they are inappropriate.

Although many elements are necessary for the growth of plants, it is found in practice that the soil supplies most of these in adequate amounts, except perhaps in the case of nitrogen, phosphorus, and potassium. Therefore maximum yields are often obtained when these three elements are supplied either singly or in combination in the form of a suitable fertiliser.

The factors governing a response to fertiliser (such as the initial soil fertility, the type of crop grown, the climate and the type and method of fertiliser application) are so variable as to make any general recommendation as to what is the best fertiliser to use a very difficult question, unless a sound and intimate knowledge of the conditions operating is obtained. Fortunately considerable latitude is permissible in the amounts and proportions of the different fertilisers that will result in satisfactory yields. The only sound method at present of finding out the exact fertiliser requirements of any particular crop under certain specific conditions is along the lines of many and varied, well-conducted, fertiliser trials.

The two popular fertilisers used in market gardening are blood and bone manure and potato manure and if we examine the composition and functions of these two manures we can provide ourselves with lessons in the principles of the correct use of fertilisers.

Blood and bone manure contains nitrogen and phosphorus and practically no potash. In market garden practice the special use of blood and bone is as a comparatively slow but lasting source of nitrogen. Being relatively insoluble it can be liberally applied to the ground and foliage without causing leaf "burn." Being a comparatively slow-acting form of nitrogen its excessive use will not induce potash deficiency as readily as the more soluble and quick-acting forms of nitrogen such as nitrate of soda, and sulphate of ammonia.

Potato manures in Western Australia generally contain nitrogen (as sulphate of ammonia), phosphorus (as superphosphate) and often in addition, potassium (as muriate or sulphate of potash).

Many growers prefer to buy the ingredients separately and make up their own mixtures which they believe from experience to be the best for that particular crop under their particular conditions.

Phosphate and potash are usually fairly well retained by the soil and are needed to a large extent early in the life of the plant. Nitrate, on the other hand, is easily leached out of the soil and is needed continually throughout the growth period.

A consideration of these principles allows us to make the general recommendation that potato manures or other complete mineral fertilisers should be applied at or about planting time, and depending on the needs of the crop, the weather, and the nature of the soil, further side dressings of nitrogen in the form of sulphate of ammonia or nitrate of soda should be applied if necessary.

The practical effects of the three fertiliser elements are briefly as follows:—

Nitrogen promotes leafy growth and is therefore of prime importance for such crops as lettuce and cabbage. In excess it may delay fruiting and maturity, favour certain diseases, and induce potash deficiency.

Phosphorus plays an important part in the general growth of the plant. It is most important early in the life of the plant and hastens fruiting and maturity.

Potassium.—A plentiful supply enhances the plant's ability to resist disease and adverse conditions. It is often an insurance against the bad effects produced by an excessive application of readily-soluble nitrogenous fertilisers.

AN ANALYSIS OF THE REPORTED FERTILISER PROBLEMS.

After discussions with the growers it became apparent that their fertiliser problems involved two factors, namely:—

1. *Nitrogen Nutrition.*—As blood and bone manure is regarded by the York market gardeners as the perfect fertiliser for their lettuce crop it is logical to examine the known properties of this manure in a study of their fertiliser problems. Many recent local fertiliser experiments with vegetables have indicated that in practice the main value of blood and bone as a fertiliser is as a comparatively slow but lasting source of nitrogen. If the main need at York for the lettuce crop is nitrogen, then the potato manure being used was a wasteful method of applying it.

The reported growth history of previous lettuce crops grown with potato manure suggested a nitrogen deficiency in the later stages of growth. It was the custom to apply 15 cwts. per acre of a certain potato manure. This supplied about 1 2/3rds cwts. per acre of the nitrogenous fertiliser, sulphate of ammonia, and the lettuces were not "finishing" under this treatment.

Therefore the evidence suggested that the nitrogen nutrition of this crop was inadequate.

2. *Fertiliser Injury.*—It was stated that potato manure at 15 cwts. per acre was responsible for fertiliser injury, by direct contact with the foliage and by root "burning." In the past, according to the growers, they were not worried by this problem when blood and bone manure was used. It is a fact that blood and bone manure, being comparatively insoluble, can be applied rapidly and safely, while the same methods used with soluble mineral fertilisers could result in fertiliser injury to the roots or foliage.

Foliage "burn" is due to allowing soluble fertilisers to lie on the leaves of sensitive plants, while fertiliser root injury is related to the concentration of the soil solution in contact with the roots as a result of heavy applications, or unsuitable placement of soluble fertilisers.

It is therefore obvious that where fertiliser injury is liable to occur its harmful effects can be minimised by—

(a) Keeping the soluble fertilisers as much as possible off the foliage.

(b) Adopting a suitable method of fertiliser placement.

(c) The judicious use of sprinkler irrigation where this is available.

THE SELECTION OF EXPERIMENTAL TREATMENTS AND CROP.

In the light of the possible effect of the two factors discussed above an experimental design was worked out for a lettuce crop embodying the principles previously discussed.

The lettuce crop was chosen because the growers considered that this crop could not be grown successfully with potato manure. It was believed that if mineral fertilisers could be used satisfactorily with this reputedly sensitive crop

it would amply demonstrate their suitability for the more hardy crops, such as cauliflower and celery, if suitable manurial methods were adopted.

Previous experience suggested that three cwts. per acre of sulphate of ammonia would be a satisfactory nitrogenous fertiliser dressing for this crop under the circumstances. If insufficient in one application, because of losses by leaching, this rate should at least prove sufficient if applied in three equal fortnightly applications.

Potash, at two cwts. per acre, was considered sufficient, if a potash deficiency was operating. Muriate of potash was used in preference to sulphate of potash because muriate is more liable to cause fertiliser injury than is sulphate.

Superphosphate, at the rate of 10 cwts. per acre, was added to make the total fertiliser mixture up to 15 cwts. per acre on the assumption that, if 15 cwts. per acre of potato manure was causing fertiliser injury, then it would also occur with this rate of complete fertiliser mixture.

Thus the basic experimental mineral fertiliser mixture selected was:—

Sulphate of ammonia (20 per cent. N)	3 cwts. per acre
Superphosphate (18 per cent. P_2O_5)	10 cwts. per acre
Muriate of potash (60 per cent. K_2O)	2 cwts. per acre
Total application rate	15 cwts. per acre

The composition of this basic experimental mixture is 4 per cent. nitrogen (N), 12 per cent. phosphoric acid (P_2O_5), and 8 per cent. potash (K_2O).

Also, it was considered that under these conditions, it might be possible to omit from the complete fertiliser mixture those components that are not essential for increased growth and also thereby limit the possibility of fertiliser injury. For instance, superphosphate and/or potash might not be necessary for this particular crop on this fertile soil in the light of its previous fertiliser history.

It was decided that the treatments derived from this basic application of 15 cwts. per acre of mixed fertiliser should be applied in one and three applications, so that reduced rates of application could be tried for its effect on possible fertiliser injury, and also the principle of split applications of nitrogenous fertilisers could be investigated under these particular conditions. Two treatments would therefore have been three cwts. of sulphate of ammonia only, in one and three applications, but it was later considered advisable to include two cwts. of superphosphate per acre with these two treatments to guard against the possible need for some readily available phosphate.

Because of the acute shortage of blood and bone manure the rationing authorities found it necessary about the time of this experiment to ration this fertiliser at the rate of three cwts. for each acre of certain priority crops planted. It was not contended that this ration in itself was sufficient but rather was it a method of fair distribution. The growers were urged to supplement their blood and bone ration with artificial fertilisers and fertiliser experiments with a variety of crops were conducted to demonstrate that mineral fertilisers, when applied correctly, could replace the usual heavy rates of blood and bone manure. Thus two obvious treatments in this case were blood and bone manure at three cwts. and 20 cwts. per acre. A treatment consisting of blood and bone manure at 10 cwts. per acre was also included because this supplied organic nitrogen equivalent to the inorganic nitrogen contained in three cwts. of sulphate of ammonia.

In order to have some measure of the inherent soil fertility a no-fertiliser treatment was also tried.

In consequence the ten experimental fertiliser treatments for this lettuce crop were as follows:—

Experimental Fertiliser Treatments.

Treatment A.—No fertiliser.

Treatment B.—Blood and bone manure at three cwts. per acre, applied one week after transplanting.

Treatment C.—Blood and bone manure at 10 cwts. per acre, applied one week after transplanting.

Treatment D.—Blood and bone manure at 20 cwts. per acre, applied one week after transplanting.

Treatment E.—A complete artificial fertiliser mixture applied at the rate of 15 cwts. per acre, one week after transplanting and containing—

Sulphate of ammonia	3 cwts. per acre
Superphosphate	10 cwts. per acre
Muriate of potash	2 cwts. per acre

Treatment F.—Same as treatment E but applied in three equal dressings of five cwts. per acre—

(a) One week after transplanting.
(b) Three weeks after transplanting.
(c) Five weeks after transplanting.

Treatment G.—Treatment E minus potash—

Sulphate of ammonia	3 cwts. per acre
Superphosphate	10 cwts. per acre

applied in one application one week after transplanting.

Treatment H.—Same as treatment G, but applied in three equal dressings of 4 1/3rd cwts. per acre—

(a) One week after transplanting.
(b) Three weeks after transplanting.
(c) Five weeks after transplanting.

Treatment J.—Sulphate of ammonia as in treatment G, but superphosphate reduced to two cwts. per acre—

Sulphate of ammonia	3 cwts. per acre
Superphosphate	2 cwts. per acre

applied in one application one week after transplanting.

Treatment K.—Same as treatment J, but two cwts. per acre of superphosphate applied at first application and sulphate of ammonia applied in three equal dressings of one cwt. per acre each—

(a) One week after transplanting.

(b) Three weeks after transplanting.

(c) Five weeks after transplanting.

THE EXPERIMENTAL SITES AND LAYOUT.

It was originally planned to conduct full scale fertiliser experiments with lettuces on three different properties. Two of these sites would have been laid down on the typical red-brown soil of the York gum and jam country which is the main soil type used for vegetable growing at York. The third site was on soil of limited occurrence, being a grey-brown gritty, loamy sand occurring as a tongue of seepage or moister soil coming away from a rock outcrop.

Later, however, it transpired that it was not convenient for one of the co-operating growers to undertake an experiment, while another could only accommodate a trial of two replications.

Fortunately Messrs. Kodra Bros., who specialise in large-scale lettuce culture, were able to provide a suitable site for an experiment consisting of 10 treatments replicated six times, using the randomised block method of layout. The site was representative of a large proportion of the York market gardens, having originally carried York gum and jam and the soil being described as a red-brown gritty sandy loam to approximately 12 inches on to red-brown clay. Therefore in the first week in April, six adjacent beds, each one chain long, of newly transplanted lettuce were reserved amongst the commercial crop on this property for a fertiliser experiment.

Mr. N. Hassen was able to provide from amongst his commercial crop two beds of transplanted lettuce seedlings so that in this case the experiment of 10 treatments could only be duplicated. The soil at this site is a grey-brown gritty loamy sand, forming part of a seepage channel below a rock outcrop. This soil is lighter in texture than the typical York gum and jam country, and would normally be judged as less fertile. However, this site had been very heavily manured in the past with dressings of horse manure.

The two growers concerned supplied the planted experimental sites and undertook the necessary sprinkler irrigation, weeding, and cultivation, while the Department of Agriculture supplied and applied the calculated amounts of the appropriate fertilisers and manures for each numbered plot, consisting of five rows each containing five lettuce plants.

The fertilisers were applied as surface bands four inches wide down the centre of each row, then lightly cultivated in, and finally watered in with the sprinklers. Reasonable care was taken to see that as little as possible of the fertiliser

lodged on the foliage. This procedure was not as rapid as the usual method of applying blood and bone manure but there is no doubt that under commercial conditions a rapid technique could soon be evolved. Machine distribution of fertiliser should be helpful in this regard.

OBSERVATIONS DURING GROWTH.

At regular intervals during growth a comparative assessment of vigour was made on each of the plots. Points were allotted to represent the visual differences in vigour of the lettuces in the various plots.

1. *N. Hassen's Amended Experiment.*—As an experiment the amended trial on this property was unsatisfactory although the lettuces produced were of high quality. Stock broke in and ate and trampled on many of the lettuce plants, thus making any estimates of yield unreliable. For this reason the lettuces in this experiment were not cut and weighed to provide yield data.

The observations made during the growth of this experimental crop indicated that there was no difference between any of the treatments. That is, no fertiliser was as good as the heaviest rates applied. It appears that the built-up fertility of the soil was such as to allow of no extra benefit when additional fertilisers were used.

It should be noted, however, that no obvious symptoms of fertiliser injury were recorded even where high rates of artificial fertilisers were applied.

2. *Kodra Bros'. Full-scale Experiment.*—The cultural details of this experiment are as follows:—

Lettuce Variety—"Imperial D."

Seedlings transplanted, 4th April, 1946.

First application of fertiliser, 12th April, 1946.

Second application of fertiliser, 26th April, 1946.

Third application of fertiliser, 7th May, 1946.

Lettuces harvested, 11th June, 1946.

The method adopted, in assessing the relative vigour of each plot, was for the grower himself to grade the lettuces without any reference to a plan of the experiment. The complicated nature of the experiment (there being sixty plots with the 10 treatments scattered at random within each of the six blocks) ruled out the possibility of memorising the treatment of any particular plot so that personal bias could not enter into the grade awarded to any treatment. In the absence of Mr. Kodra, the authors themselves conducted the assessment along the same lines.

It was initially suggested that the grower confine himself to five classes and the following terms were used: bad, poor, medium, good, and very good. On this basis of classification, in order to simplify the tabulation of results, points were allotted for the five classes, namely, 2, 4, 6, 8 and 10. Where a plot was judged as lying between two classes it was assessed as the appropriate odd number. As there were six plots to each treatment the maximum possible score was 60.

The results of this method of grading are summarised in Table I.

TABLE I.

FERTILISER EXPERIMENT WITH LETTUCES—KODRA BROS., YORK—APRIL-JUNE, 1946.

Summary of Grading Points.

(Maximum Possible Score—60.)

Treatment.	26-4-46.	7-5-46.	15-5-46.	23-5-46.	30-5-46.	Harvest, 11-6-46.
A. No fertiliser	22	16	16	14	14	*17
B. Blood and bone, 3 cwts. per acre	34	24	23	23	26	*32
C. Blood and bone, 10 cwts. per acre	34	28	31	29	32	*34
D. Blood and bone, 20 cwts. per acre	38	44	39	41	43	42
E. 10 cwts. super., 3 cwts. sulphate of ammonia, 2 cwts. muriate of potash, in 1 application ...	40	50	50	50	43	42
F. 10 cwts. super., 3 cwts. sulphate of ammonia, 2 cwts. muriate of potash, in 3 equal applications	38	38	39	43	46	45
G. 10 cwts. super., 3 cwts. sulphate of ammonia, in 1 application	40	46	47	50	46	46
H. 10 cwts. super., 3 cwts. sulphate of ammonia, in 3 equal applications	38	38	35	41	41	43
J. 2 cwts. super., 3 cwts. sulphate of ammonia, in 1 application	44	50	50	53	46	46
K. 2 cwts. super., in 1 application, 3 cwts. sulphate of ammonia in 3 equal applications ...	34	34	36	38	39	44

* Favoured by inclusion of buffer rows.

Note.—No time was available to make a grading of the plots before harvesting commenced. To remedy this omission a set of figures was estimated from the gross returns per acre on the basis of a grading of 46 for the maximum monetary yield.

DISCUSSION OF TABLE I.

Table I illustrates, by means of points allotted for vigour during the progress of the experiment, and for yield at harvest time, the effects of the six different rates and methods of applying nitrogenous fertilisers. The figures show that—

1. The no-fertiliser treatment as a commercial crop was a failure. The comparative vigour declined during the experiment and the lettuces were a pale green colour.

2. Blood and bone manure at three cwts. per acre did not supply sufficient nitrogen for satisfactory growth. The plants were pale in colour and compared with the treatments receiving adequate nitrogen the difference in growth became progressively worse from a few weeks after transplanting until harvest time.

3. Blood and bone manure at 10 cwts. per acre still did not supply sufficient nitrogen for satisfactory growth. This treatment resulted in a pale green foliage but gave more vigorous lettuces than those in the two previous treatments. However, the crop produced did not reach satisfactory commercial standards.

4. Blood and bone manure at one ton per acre gave fairly vigorous growth at all stages and produced a good commercial crop.

5. Those treatments receiving three cwts. per acre of sulphate of ammonia, as one application a week after transplanting, were initially very vigorous and finally produced a good commercial lettuce.

6. Where three cwts. per acre of sulphate of ammonia was applied in three equal split dressings, it was found that although growth in the early stages was relatively backward, the lettuces later improved rapidly and continued on to produce a good commercial crop. Therefore sulphate of ammonia at the rate of one cwt. per acre gave, apparently, an insufficient supply of nitrogen in the early stages of growth. It was not until the full effect was felt of the two subsequent fortnightly side-dressings that these treatments caught up with those receiving three cwts. per acre of sulphate of ammonia, a week after transplanting.

THE HARVESTING OF KODRA BROS'. EXPERIMENT.

Originally it was planned to cut only the centre lettuces of each plot and discard the buffer rows, but as these methods would have interfered with the grower's harvesting operations, yield data was finally obtained from a complete plot of 25 lettuces.

It was observed during the growth of the experimental lettuces that the buffer rows (the outside lettuces adjacent to another fertiliser treatment) in treatment A (no fertiliser), treatment B (three cwts. per acre of blood and bone), and treatment C (10 cwts. per acre of blood and bone) had obviously benefited by feeding into the fertiliser supplies of the adjacent treatments. This was not the case with the other seven treatments because at harvesting time they presented a fairly uniform appearance throughout the plot.

Thus the harvest figures presented in Table II favour the first three treatments which would have made an even poorer showing had the outside buffer rows been discarded. Fortunately this does not detract from the purpose of the experiment because the yield data, even as presented, provide sufficient evidence to demonstrate the fertiliser principles involved.

The harvested lettuces were marketed as "Fancy" and "1st Grade" and the prices obtained on a favourable market were 6s. 6d. a dozen for "Fancy" and 4s. a dozen for "1st Grade." It was then estimated what would have been the gross return per acre for each particular treatment. These figures have been added to the harvesting data in Table II. The lettuce plants were so spaced as to give 35,000 lettuces to the acre, inclusive of paths. It is not suggested that these prices are average returns, but they do at least provide comparable figures and have the added advantage that they are the actual market prices obtained.

An examination of the yield data indicates that in this particular instance the grading into "Fancy" and "1st Grade" was largely a matter of relative weights. Naturally, the heavier the lettuce the greater would be the size and density of the heart. When stripped ready for market, the average weight of a "Fancy Grade" lettuce was one pound nine ounces, while the average weight of a "1st Grade" lettuce was one pound two ounces.

The lettuces shown in the table as "not cut" consist of "rejects" unfit for sale and a small proportion which were cut on 20th June and which, despite the extra growth time allowed, could only reach "2nd Grade." For the sake of clarity these second cuts, which do not materially affect the results, were omitted from the table.

TABLE II.

FERTILISER EXPERIMENT WITH LETTUCES—KODRA BROS., YORK—APRIL-JUNE, 1946.

Yield Data—Harvested 11th June, 1946.

Yield from 6 plots of 25 Lettuces = 150 Lettuces.

Treatment.	Fancy Grade.		1st Grade.		Total Cut.		Lettuces not Cut.	Lettuces which died.	Gross Return.
	Number.	Weight.	Number.	Weight.	Number.	Weight.			
		lb. ozs.		lb. ozs		lb. ozs.			per acre.
A. No fertiliser	26	40 0	37	40 7	63	80 7	87	....	£310
B. Blood and bone, 3 cwts. per acre	64	97 15	45	50 2	109	148 1	38	3	£580
C. Blood and bone, 10 cwts. per acre	61	90 15	61	69 2	122	160 1	26	2	£625
D. Blood and bone 1 ton per acre	100	156 7	34	38 3	134	194 10	12	4	£765
E. 10 cwt. super., 3 cwt. sulphate of ammonia 2 cwt. muriate of potash per acre—in 1 application	98	151 2	40	43 8	138	194 10	9	3	£775
F. As treatment E, but in 3 applications	120	192 14	19	21 9	139	214 7	10	1	£830
G. 10 cwt. super., 3 cwt. sulphate of ammonia, in 1 application	117	183 13	26	27 12	143	211 9	5	2	£840
H. As treatment G, but in 3 applications	102	161 15	39	45 11	141	207 10	8	1	£795
J. 2 cwt. super., 3 cwt. sulphate of ammonia, in 1 application	122	187 6	20	21 10	142	209 0	6	2	£84[illegible]
K. 2 cwt. super., in 1 application plus 3 cwt. sulphate of ammonia in 3 applications	109	173 10	29	32 4	138	205 14	11	1	£800
Difference necessary for significance P 05	....	52 3	....	....	....	39 6	....	....	....

DISCUSSION OF TABLE II.

Nitrogen.

It is obvious from the tabulated results that nitrogen was the primary fertiliser need for the lettuce crop under those conditions. When using blood and bone as the only source of nitrogen at least a ton per acre was needed for satisfactory yields. Under those conditions the three cwt. of sulphate of ammonia could be applied in one application about a week after transplanting and it is not necessary to split the nitrogenous fertiliser into three applications, as is the case on Perth sand under sprinkler irrigation, where leaching is severe. In this experiment the nitrogen content of blood and bone manure was not more than half as efficient as the nitrogen content of sulphate of ammonia. Although the arbitrarily decided rate of three cwt. per acre of sulphate of ammonia proved satisfactory in this experiment, it should not be concluded that this is the optimum rate as further trials may show that higher yields are obtained when greater applications are used.

Phosphate.

The results indicated no improvement from increases above two cwts. per acre of superphosphate. However, this result should be interpreted with caution as the past fertiliser history of this soil may have built up a high phosphate

status. This and other similar evidence throw doubt on the need for high rates of superphosphate with many of our vegetable crops when planted on "old land" which has received considerable amounts of phosphatic fertilisers in the past.

Potash.

Although the inclusion of potash in the fertiliser mixture had no beneficial effect in this experiment, it may become necessary to add potash if continual cropping, without it, is practised. The need for potash may also be accentuated if the readily soluble nitrogenous mineral fertilisers, nitrate of soda and sulphate of ammonia, are used too liberally.

Fertiliser Injury.

In this autumn-planted experimental lettuce crop, no evidence of fertiliser injury was observed even with the highest rates of application. However, it should be remembered that all reasonable precautions were taken to guard against its occurrence. The fertilisers were applied carefully in order that as little as possible fell on the leaves and a form of band-placement of fertiliser was practised.

During the course of the experiment attention was drawn to some lettuce plants which were dying and which the growers attributed to fertiliser "burn." Samples of these affected lettuces were submitted to the Plant Pathologist who diagnosed the disease as "Lettuce Drop," which appears to be very prevalent in this area during the wet winter months. Practically all the deaths, as reported in Table II, can be attributed to this fungal disease.

It is of interest to note, in view of some of the published statements regarding the respective merits of organic manures and artificial fertilisers that the evidence of this trial does not support the contention that the use of artificial fertilisers favours the incidence of disease.

RESULTS OF EXPERIMENT IN RELATION TO FERTILISER PROBLEMS.

The fertiliser experiment conducted on Messrs. Kodra Bros. property has given complete answers to the fertiliser problems submitted by the York market gardeners. They are as follows:—

1. *Rates of Blood and Bone Manure Necessary.*—If blood and bone manure is used as the sole source of nitrogen with the lettuce crop, then under these conditions it is necessary to use about a ton per acre for satisfactory yields. It can then be appreciated that while blood and bone manure is in short supply it is incumbent upon the growers to augment the ration available by using such mineral nitrogenous fertiliser as nitrate of soda, or sulphate of ammonia. The principles underlying the use of these fertilisers are discussed in this article.

2. *Fertiliser Injury.*—Fertiliser injury was not observed in this experiment. However, the procedure to be followed to minimise the likelihood of fertiliser injury has been discussed and if reasonable precautions are taken there should be no trouble even with relatively heavy applications. Furthermore, the experimental results show that low rates only of artificial fertilisers are needed when chiefly nitrogenous fertilisers are used, so that the possibility of fertiliser injury can be still further reduced by adopting a similar fertiliser mixture.

3. *The Use of Potato Manures with the Lettuce Crop.*—The original complaint was that potato manure at the rate of 15 cwts. per acre could not be successfully substituted for one ton of blood and bone per acre. As it has been

established by this experiment that the primary fertiliser need for this crop was nitrogen, the nitrogen contents of the potato manures used are now examined, in order to assess their value for this crop.

ANALYSIS OF POTATO MANURES A AND A_2.

Constituent.	A.	A_2.
Phosphoric acid (P_2O_5)	13·00%	11·56%
Nitrogen (N)	2·50%	2·23%
Potash (K_2O)	5·00%	4·45%

Note.—A_2 was substituted for A from 15th March, 1945.

The growers stated that they applied potato manures A or A_2 at the rate of about 15 cwts. per acre with poor results on their lettuce crop. Using them they were unable to produce a "finished" lettuce. At the rate of 15 cwts. per acre, potato manure A would supply 1.8 cwts. per acre of sulphate of ammonia, while potato manure A_2 would supply 1.6 cwts. per acre of sulphate of ammonia. The experimental results indicated that the nitrogen supplied by three cwts. of sulphate of ammonia was a satisfactory amount and therefore the lettuce grower, to apply this amount, would need to use potato manure A at the rate of 25 cwts. per acre and potato manure A_2 at the rate of 28 cwts. per acre. Therefore, it will be appreciated that the use of these potato manures is an inefficient method of supplying nitrogen to the lettuce crop. Had the growers been aware of the nitrogen deficiency symptoms in the lettuce crop they could have "finished" the plants, even after the initial use of potato manure, with a side dressing of nitrate of soda or sulphate of ammonia, at the rate of one to two cwts. per acre. Under the fertiliser rationing scheme extra supplies of nitrate of soda were available for side-dressing purposes.

This finding will no doubt have an application to other vegetable crops, especially where in some instances the grower claims beneficial results from exceptionally heavy applications of potato manure.

CONCLUSION.

The experiment furnishes further evidence of the fact that blood and bone manure can be replaced in vegetable growing provided a suitable mineral fertiliser mixture is applied in a manner suitable for that particular crop, climate, and soil. It had been argued that although this contention might hold good for the metropolitan area, it would not operate successfully with a lettuce crop under York conditions. The experimental evidence shows that artificial fertilisers, when properly applied, will result in satisfactory vegetable crops in the York district as well as in the metropolitan area.

It is felt that where there is a reluctance to use mineral fertilisers freely, the proper use of superphosphate, sulphate of ammonia or nitrate of soda and potash are not fully understood. Therefore the opportunity was taken in reporting this experiment to discuss more fully than would otherwise have been warranted some important aspects of plant nutrition, and to use these experimental results as illustrations, wherever possible, of the basic principles of manuring in the hope that many growers would profit from the discussions and would thereby gain a fuller understanding of their fertiliser problems.

ACKNOWLEDGMENTS.

These experiments were conducted as a co-operative effort by the Plant Nutrition and Vegetable Branches of the Department of Agriculture.

Thanks are expressed to Messrs. Kodra Bros. and Mr. N. Hassen for making available experimental sites amongst their commercial crops and for their valuable assistance in the conduct of the experiments. Also thanks are due to the Conservator of Forests, Mr. T. N. Stoate, for the statistical analysis of the results.

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1945-1946 Experiments with D.D.T. and 666 as Agricultural Insecticides.

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P. N. FORTE, Assistant Entomologist.

D.D.T.

THE use of D.D.T. or dichloro-diphenyl-trichloroethane as an insecticide ranks as one of the outstanding discoveries of the war period for, although the material was first prepared by a German chemist in 1874, it was not until 1939 that its vast potentialities as an insecticide were foreshadowed.

TOXICITY OF D.D.T.

D.D.T. is a contact as well as a stomach poison and unlike other insecticides in common use has the advantage of remaining effective as a spray or dust film for a considerable period. It is slow in action, however, and signs of distress may not be noticeable in an insect for half an hour or more after receiving a lethal dose while death may be delayed for a much longer period.

D.D.T. is toxic to mammals and consequently should be handled with care. Oil solutions are readily absorbed through the skin and therefore are unsuitable for the treatment of animals excepting under special circumstances. Dusts and emulsions are much safer and are available in forms suitable for use both on plants and domestic animals.

D.D.T. is highly toxic to fish and many other cold-blooded creatures.

D.D.T. RESIDUE ON FOODSTUFFS.

Although D.D.T. is regarded as less dangerous than many other insecticides in common use every care should be taken to prevent the accumulation of residues on vegetables and other foodstuffs. No definite tolerance limit is at present given for this State but a tentative figure fixed in the U.S.A. is seven parts per million.

The likelihood of heavy residues accumulating on vegetables such as cabbages has been investigated and the report of the Government Analyst outlined in the accompanying table shows that the residue remaining after cooking or after the useless outer leaves have been discarded is very small. At the present stage of our knowledge, however, it would be unwise to treat liberally mature lettuce or similar foodstuffs which might later be eaten with much of the residue still present.

TABLE I.—RESIDUE OF D.D.T. ON CABBAGES.

Cabbage No.	1.	2.	3.
Portion Examined ...	Heart (outer leaves discarded)	Whole Vegetable (outer leaves included)	Whole Vegetable.
D.D.T. In Raw Sample (p.p.m.)	Less than 7 ...	40	19
D.D.T. in Cooked Sample (p.p.m.)	Less than 7 ...	Less than 7 ...	Not determined

No. 1 and 2 consisted of cabbages of normal growth with hard, compact hearts.

No. 3 consisted of a cabbage with open leaves and no compact heart.

Seven parts of D.D.T. per million constitutes the lower limit which could be estimated on the quantity of material available.

PLANT INJURY.

No obvious plant injury was found associated with any of the experiments here outlined although investigations elsewhere have shown that certain plants such as young beans and melons are susceptible to some types of D.D.T. preparations. A reduction in yield from tomatoes treated with one per cent. dust has also been reported but in local experiments no such detrimental effects have been noticed.

EFFECT ON BEES AND OTHER USEFUL INSECTS.

D.D.T. is known to be toxic to bees as well as many other useful insects, but the same applies to many insecticides and this is not a sufficient reason for condemning the use of this new material. Bees are most vulnerable when blossoming plants are treated and usually dust and spray applications can be timed to avoid the blooming period.

In addition, it is of interest to note that in Germany field dustings with D.D.T. and arsenate of lead have shown that bees could withstand treatments three times the necessary strength of D.D.T. required to control rape beetle, but were killed with the minimum application of arsenate of lead.

It is doubtful whether the various pessimistic forecasts concerning the adverse effect of D.D.T. upon the balance of nature are well founded. Local upsets may occur as is instanced in the present paper where a high proportion of Bryobia mite developed on apple trees successfully treated for the control of the apple leafhopper. Dual purpose mixtures are being developed to meet some of these difficulties however, and it is claimed that white oil added to certain D.D.T. emulsions will control both leafhopper and mite.

It must not be conceived that D.D.T. will be used in a wholesale manner over the countryside to kill friend and foe alike as such an unrestricted slaughter might be fraught with dire results.

Used on comparatively small areas such as orchards and gardens, however, the effects would be very local and should be easily adjustable by future action.

PESTS TREATED WITH D.D.T.

Except where otherwise stated a 1 per cent. D.D.T. pyrophyllite dust and a 0.1 per cent. D.D.T. emulsion were the preparations used in the following experiments:—

Rutherglen Bug (*Nysius vinitor*).

Dust and spray treatments were applied to several infested plots of potatoes but no appreciable reduction in the bug population was effected.

Experimental work in the Eastern States has shown that under certain conditions satisfactory control of this pest can be obtained with D.D.T. preparations, but tests over two seasons have given negative results locally.

Apple Leafhopper (*Typhlocyba froggatti*).

A block of trees in a heavily infested Bridgetown orchard was sprayed late in November at the rate of two gallons per tree. Within 24 hours the trees were practically free of leafhoppers and no serious re-infestation had occurred in February despite the fact that adjacent untreated trees carried a high population.

A disappointing aspect of this treatment was the rapid build-up of Bryobia mite (*Bryobia praetiosa*) on the treated trees.

Vegetable Leafhopper (*Empoasca terra-reginae*).

A block of 180 tomato plants treated at approximately 10-day intervals was kept practically free of this pest while control plots were heavily infested. Treatments on potatoes and melons proved equally successful.

Cabbage Aphis (*Brevicoryne brassicae*).

No effective control of this pest was obtained with either dust or spray treatments.

Black Citrus Aphis (*Toxoptera aurantii*).

It was not possible to conduct controlled experiments against this pest but in the absence of nicotine sulphate, many growers sprayed with D.D.T. during a severe aphis outbreak in the spring of 1946. An inspection of several orange groves shortly after the treatment indicated that D.D.T. was toxic to this species of aphis and that satisfactory control could be obtained from D.D.T. sprays.

Scale Insects.

Spray treatments were applied to citrus trees heavily infested with White Wax Scale (*Ceroplastes destructor*), Black Scale (*Saissetia oleae*) and Red Scale (*Aonidiella aurantii*). The sprays were applied just prior to the main emergence of the crawlers in the hope that the D.D.T. film would inhibit the settling down of the young. These treatments gave no better results, however, than those applied at the time of maximum crawler activity the previous season when no success was obtained.

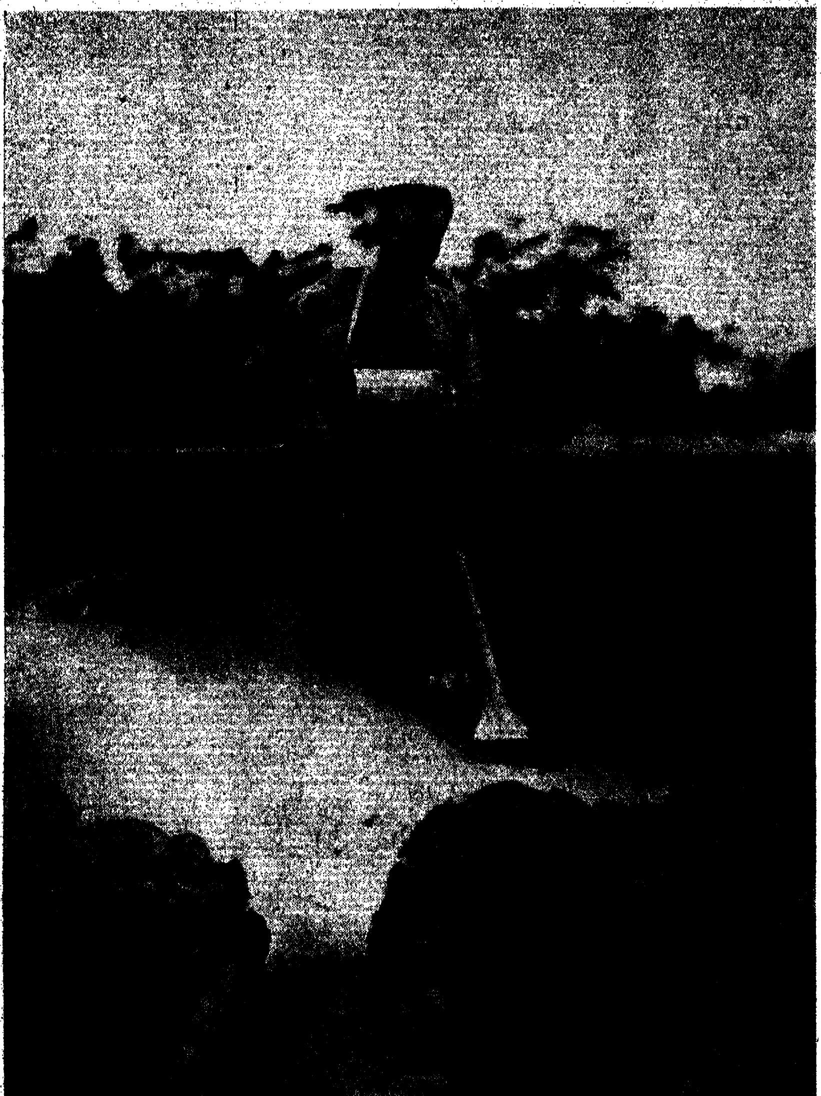

Plate 1. Cabbages being dusted with a hand rotary duster.

Little Plague Grasshopper (*Austroicetes cruciata*).

The following formula was tested against grasshoppers in the Eastern Wheatbelt:—

10 per cent. D.D.T. pyrophyllite powder ..	1 lb.
Bran	24 lbs.
Molasses	6 lbs.
Water	2½ galls.

The results obtained were very similar to those associated with the arsenite of soda bait both being slower in action than the 666 mixture.

Apple Curculio (*Otiorrhynchus cribricollis*).

Two blocks of apple trees were sprayed with 0.1 per cent. D.D.T. emulsion. In one case the entire trees were sprayed; in the other, the trunks and lower limbs only were treated. The results were inconclusive as there was little weevil activity following the time of treatment on sprayed or unsprayed trees.

Argentine Ant (*Iridomyrmex humilis*).

The following treatments were applied in a citrus orchard carrying a heavy scale and ant population. The trees were all pruned so that none of the branches could touch the ground.

Hessian Bands.—Hessian bands about 12 inches wide saturated with 20 per cent. D.D.T. emulsion tied around the butts of the trees proved effective in preventing the ants climbing to the scale infested branches. Care was necessary to see that the bands were in contact with the trees all the way around as in several instances ants were found crawling up between the trunk and the bandage.

D.D.T. Paste Bands.—Bands consisting of a water paste of 3 per cent. and 5 per cent. D.D.T. on pyrophyllite proved ineffective.

Plate 2. Spraying main trunks of lemon trees with D.D.T. for control of Argentine Ants.

D.D.T. Sprays.—Sprays were all made from D.D.T. emulsion and were applied with a knapsack spray pump so as to saturate the trunk and lower limbs up to three feet six inches from the ground.

1 *per cent. D.D.T. Emulsion.*—Ants infesting sprayed trees were rapidly killed and the trees remained free of ants for seven weeks and up to 14 weeks later a very light infestation only was in evidence.

0.5 *per cent. D.D.T. Emulsion.*—Controlled infestation and kept trees clean for five weeks, then ant population gradually increased.

0.1 *per cent. D.D.T. Emulsion.*—Controlled ants for three weeks followed by a gradual build up of numbers.

It seems possible that the colonies usually infesting the trees used in the experiment were completely killed out and that as the effect of the D.D.T. residue gradually decreased, reinfestation occurred.

The use of D.D.T. sprays in preventing household invasions has been found equally effective.

House and Stable Flies (*Musica domestica and Stomoxys calcitrans*).

A suburban dairy which carried a very high fly population of the above species was selected to try the usefulness of D.D.T. on these pests.

A 4 per cent, solution of D.D.T. in power kerosene was used and one cow in 10 was sprayed on the legs and shoulders while in the bail. To avoid possible injury to the skin, the spray was applied as a mist which settled in fine droplets on the hairs and did not saturate the hide. The same cows were treated each time and treatments were given twice a week. Several selected places on the walls of the milking shed were also sprayed.

This treatment rapidly reduced the population of both species of flies to low proportions.

Observations made at the same dairy several weeks after the treatment ceased showed that the fly population was returning to the pre-treatment level.

Buffalo Fly (*Siphona exigua*).

Tests for the control of buffalo fly on cattle were carried out at Broome in August when flies, although not at their maximum, were sufficiently numerous for experimental purposes.

Three proprietary preparations were used, viz., Benzophen, Benzophen plus D.D.T. and "Rucide."* Benzophen has been used for many years past to treat all beasts shipped South from North-West ports. Both the D.D.T. mixtures were used at .5 per cent. concentrations and proved more effective than Benzophen alone but "Rucide" was superior to the other two and beasts sprayed with this preparation remained free of flies for 12 days after which period no further observations were taken.

*A proprietary D.D.T. preparation.

Cabbage Moth (*Plutella maculipennis*).

Two patches of cauliflowers each of 1,050 plants grown under sprinklers were treated at 10-day intervals one with 0.1 per cent. D.D.T. emulsion and the other with 1 per cent. D.D.T. pyrophyllite dust. Complete control of cabbage moth caterpillars was obtained with both treatments.

Climbing Cutworm (*Heliothis armigera*).

Two acres of mature flax were dusted with a Y2 Powderdust at the rate of 25 lbs. per acre. The caterpillar population before treatment was 12-15 per square feet and severe seed losses were being caused.

Injury had already occurred to the patch selected for treatment as for uncontrollable reasons the dusting was a little late. Further injury was prevented by one treatment, however, and the comparative seed yield may be estimated from the accompanying illustration.

Plate 3. Undusted and dusted sheaves of flax showing difference in cutworm injury.

A block of 180 tomato plants was dusted at approximately 10-day intervals and complete protection against cutworm injury was obtained.

False Looper Caterpillar (*Phytometra argentifera*).

A variety of heavily infested crops including potatoes, lettuce, silver-beet and cabbages was dusted and sprayed against this pest and a very satisfactory control was obtained.

Cabbage Butterfly (*Pieris rapæ*).

Results similar to that outlined for cabbage moth.

Red-Legged Earth Mite (*Halotydeus destructor*).

Preliminary experiments with 1 per cent. D.D.T. dust gave good control of this mite. Trials were carried out on seedling flax plants and young garden peas. The plants and surrounding soil were lightly dusted and two hours later the mites present were nearly all incapacitated. The following day only a few live mites could be detected although dead ones were plentiful. Three days later, no live mites could be detected and the crop matured without further mite injury.

Cattle Tick.

No special tests were carried out but indications were that 0.5 per cent. "Rucide" when used against the Buffalo fly was also effective against cattle tick.

"GAMMEXANE" Or 666.

666, Gammexane or Benzenehexachloride like D.D.T. is not a new substance having been made by Michael Faraday as far back as 1825 but it was not until 1941 that intense research by British chemists showed it be a worthy competitor with D.D.T. and for certain purposes unequalled.

TOXICITY OF "GAMMEXANE."

The effect of "Gammexane" upon the insect is very similar to that produced by D.D.T. The material is much less toxic to the higher animals, however, and so is superior to D.D.T. for certain purposes.

From the following results it will be seen that "Gammexane" proved ineffective against a number of local pests. Spray treatments proved superior to dusting, however, where the two were applied under similar conditions and the great difference between the efficiency of the two treatments indicates that there is ample scope for investigation into the preparation of mixtures and the methods of application.

PLANT INJURY.

No plant injury resulting from the use of "Gammexane" was detected following any of the treatments applied.

PESTS TREATED WITH 666.

Rutherglen Bug (*Nysius vinitor*).

Two rows 200 ft. long of well grown potatoes were used in the experiment, one area being dusted with 2 per cent. "Gammexane" dust and the other being sprayed with 0.2 per cent. "Gammexane" emulsion. No effect could be observed on the bug infestation.

Apple Leafhopper (*Typhlocyba froggatti*).

A block of trees in a heavily infested Bridgetown orchard was sprayed in late November at the rate of two gallons per tree with 0.15 per cent. "Gammexane" emulsion. No reduction in the leafhopper population could be detected.

Vegetable Leafhopper (*Empoasca terra-reginæ*).

Tomatoes infested with leafhopper were dusted with 2 per cent. "Gammexane" dust at fortnightly intervals but this failed to reduce leafhopper damage.

Scale Insects.

The tests made with "Gammexane" against scale insects were similar to those outlined under the heading of D.D.T. and equally disappointing results were obtained.

Cabbage Aphis (*Brevicoryne brassicae*).

No apparent control was obtained by the use of 2 per cent. "Gammexane" Dust

Little Plague Grasshopper (*Austroicetes cruciata*).

The following formulae were tested against grasshoppers in the Eastern Wheatbelt:—

(a) 10 per cent. Gammexane powder	1 lb.
Bran	24 lbs.
Molasses	6 lbs.
Water	2½ galls.
(b) 10 per cent. Gammexane powder	1 lb.
Bran	24 lbs.
Water	2½ galls.

The insects ranged from 1st instar nymphs to fliers but the majority were 3rd and 4th instar hoppers.

The bait was broadcast in the middle of the morning but as a cool wind was blowing the insects did not feed readily until about noon when the conditions were warmer. Both baits were readily taken and within one hour a large number of hoppers were incapacitated. Twenty-four hours after treatment the mortality was very heavy and only a few live insects remained on the treated area. As no attempt was made to isolate the treated plot there is no doubt that many of these live hoppers had migrated on to the area after the laying of the bait. Bait two days' old and apparently quite dry was readily eaten by the hoppers and the sweetened bait appeared to be no more attractive than that lacking molasses.

Plate 4. Cabbages being dusted with D.D.T. by means of a wheelbarrow duster.

Apple Curculio (*Otiorrhynchus cribricollis*).

Tests with 0.15 per cent 666 emulsion were conducted in association with the D.D.T. trals but in both cases results were inconclusive.

Cabbage Moth (*Plutella maculipennis*).

One trial was conducted on a block of cabbages and cauliflowers grown under sprinklers and 1,050 plants were dusted with 2 per cent. "Gammexane" dust at 10-day intervals throughout the growing period.

A crop of cauliflowers grown under swamp conditions was also treated and 400 plants were dusted as in the first trial.

Control of the caterpillars was so poor that the crop was finally treated with D.D.T. to prevent a complete loss to the grower. In contrast to the poor results obtained with "Gammexane" dust good control was obtained on a block of 450 cauliflowers treated at 10-day intervals with 0.2 per cent "Gammexane" emulsion.

Plate 5. Cabbages being dusted with D.D.T. by means of a wheelbarrow duster.

Climbing Cutworm (*Heliothis armigera*).

A block of 180 tomato plants was dusted with 2 per cent. "Gammexane" dust at fortnightly intervals. No serious caterpillar injury occurred, but as the damage on control plants was also very light the test was inconclusive.

Cabbage Butterfly (*Pieris rapæ*).

Results similar to those outlined for the cabbage moth.

SUMMARY.

D.D.T.

D.D.T. did not kill all important insect pests and many mites proved particular resistant. It was very effective against caterpillars and cabbages and cauli-

flowers treated periodically with a 1 per cent. D.D.T. dust were practically free from all signs of chewing injury. Tomato plants treated from seedling to maturity showed a marked reduction in the number of "wormy" fruits.

D.D.T. sprays proved very effective in controlling the buffalo fly, house flies, and stable flies.

Other pests against which D.D.T. gave very satisfactory results were Argentine ant, climbing cutworm, apple leafhopper, vegetable leafhopper and cattle tick.

Indications are that leaf eating orchard pests can be controlled by 0.1 per cent. of D.D.T. sprays but tests against scale insects and many aphids have been disappointing and Bryobia mite appears to be quite unaffected. Much still remains to be learned before D.D.T. can be indiscriminately recommended. Unfortunately it is toxic to mammals as well as to many useful insects such as ladybirds, wasps and bees. Used with discretion, however, its bad effects can be minimised and its beneficial properties exploited.

GAMMEXANE.

"Gammexane" proved inferior to D.D.T. in the present tests against most insect and allied pests. Used in grasshopper baits it proved very much quicker in action than either D.D.T. or arsenite of soda. The superior results obtained from sprays when compared with dusts indicate the need for research into the preparation of mixtures and the methods of application.

"Gammexane" is much less toxic to mammals than D.D.T. or arsenic and consequently has definite advantages over these insecticides for certain purposes.

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Pasture Plants of the Kimberleys.

A Preliminary Report on Their Composition.

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MUCH publicity has been given of recent years to the urgent need for developing the northern areas of Western Australia. The Kimberleys, because of the more assured rainfall and the possibilities of irrigation from storage dams built on the Ord River, have received particular emphasis as possible areas of intensive development. The problems of geographic isolation, and of markets for produce, still remain as handicaps to closer settlement but there is reason to hope that the pastoral industry may make considerable advances in the immediate future. And a prosperous pastoral industry may well be the fore-runner of some form of closer settlement.

Since about 1890 cattle have been grazed in the Kimberleys on a very extensive system but the numbers over many years have shown no increase, and the quality of the beef produced, as shown by carcase weight and the percentage reaching export standard, has tended to decline. Of more significance is the fact that pastures carrying cattle have deteriorated, many of the more useful plants and edible shrubs having been replaced by weeds and short lived annuals. The subsequent loss of protective vegetative cover has exposed the soil to the ravages of wind and rain, so that on certain soil types erosion is already a serious problem.

The Kimberley area is essentially pastoral and is likely to remain so for many years. It follows that it is very important to learn everything possible regarding methods by which the natural pastures may be maintained or improved. Under present conditions, feed for cattle is very scarce for months before the rainy season begins, so that the young herbage, when it does appear, tends to be severely overstocked. At a latter stage the feed "gets away" from the stock, and the profuse growth of rank, fibrous grass becomes unsuitable even for cattle. When this mature low-quality herbage becomes dry at the end of the "wet," the grazing animal has to exist for six months or more on very poor quality roughage. There is thus an urgent need for fodder plants which will provide a bulk of feed soon after the first rains, and which will continue to provide green feed for as long as possible after the rains have ceased. During the last twenty or thirty years the changes in the vegetation have tended to reduce the growing period of the Kimberley pastures. These changes must be arrested and reversed. Not only is it urgent to extend the period during which growth takes place but a study must be made of methods whereby the lush mid-season growth may be controlled and conserved. A Research Station has now been established at Ivanhoe on the Ord River, so that these and associated problems may receive attention, thus assisting the pastoral industry to take every advantage of the natural resources of the region.

As a preliminary step in the study of pastoral management it is essential to know something of the composition of the natural herbage. Efforts can then be made to encourage the growth of the more useful plants and to make introductions which are most likely to correct any deficiencies disclosed. To obtain this essential information, a series of samples of grasses grown at Ivanhoe were collected at various stages of growth, and have been analysed to give some index of the relative nutritive value. These analyses are discussed in this paper.

It should be emphasised, however, that many factors affect the chemical composition of plants—season, stage of growth, soil type, management, etc.—and the results recorded here can only be discussed in very general terms. But much of the data are very interesting and give valuable leads for future work.

Experimental.

The various pasture types discussed in this paper were collected from plots in the vicinity of Ivanhoe. In most cases small areas of the naturally growing plants were fenced in so as to be protected from grazing animals, otherwise no treatment at all was given. The areas had been subjected to heavy grazing until towards the end of December, 1944, and this heavy grazing appears to have had a particularly crippling effect on early maturing grasses such as Para. Grasshoppers at times were bad and these doubtless depleted the test plots of some of the more palatable herbage.

Portions of the plots were cut at intervals, the whole of the growth being ground for analyses. This meant that much fibrous matter which normally would not be eaten by stock was included in the material as analysed, hence some of the high figures for crude fibre. A better index of the true feed value would have been obtained had the samples been handpicked to represent that proportion most likely to be eaten by the grazing animal.

The samples were not weighed and no data are available concerning the relative yields from the various plots.

Rainfall.

From July, 1944, until September, 1945, 26.83 inches of rain fell as follows:—

1944.						1945.								
July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
0	0	0	248	46	594	580	702	357	156	0	0	0	0	0

It will be seen that the summer rains are restricted to a definite wet period, no rain being recorded during the dry months. The 1944-45 "wet" was one of subnormal rainfall, the recording for 1943-44 being 39.10 inches and for 1945-46, 34.59 inches.

Soils.

All but two of the grasses examined were obtained from plots on ORD SANDY LOAM, a red alluvial soil laid down by the river. Two plots were situated on CUNUNARRA CLAY, a heavy black soil typical of that found on the extensive Ivanhoe plains.

Analyses.

The analyses were carried out in the Government Chemical Laboratories, standard methods being used in all cases.

Results.

The results have been recorded in detail in the Tables included in this paper. The quality of the various grasses will be discussed in turn.

Buffel and Birdwood Grass (Cenchrus spp.) Table I.

Pastoralists will be particularly interested in the analyses of the samples of Buffel and Birdwood grass recorded in Table I. These grasses have attracted considerable attention of recent years as they give promise of becoming very valuable in tropical and subtropical areas. It is therefore pleasing to learn that not only are these grasses hardy and resistant to heavy grazing, but also that they have a high nutritive value.

Buffel Grass was apparently introduced into this State via Port Hedland about 1910, seeds being present in the chaff brought in with camel teams. It is now well established in pastoral country from Carnarvon northward and although for a long while it was looked upon as a "coastal" grass, good stands have been seen up to a hundred miles inland. Stock are very fond of Buffel Grass and overgrazing has doubtless been the main factor in limiting its spread.

Birdwood Grass is similar to Buffel and was introduced from India by General Birdwood, hence its name. It is a pity that there were not distinct plots of these two grasses at Ivanhoe, so that comparisons could be made regarding relative yields and composition. Comparative work will be carried out in due course.

From the details given in Table I it can be seen that these grasses came away well with the first rains, giving "good quality bulky pasture" despite heavy stocking. A very pleasing rapidity of growth took place as soon as the plots were fenced, the sample cut on January 3rd having grown up to three feet high in three weeks. This material had an excellent analysis, containing more crude protein (14 per cent) than most cereal grains. But if left uncut or ungrazed, Buffel grass, like most others in the tropics, quickly matures, becoming rank and fibrous with relatively little digestible protein. This deterioration is shown by the progressive changes in Samples 2, 3 and 4, the sample cut on 20th February containing only one third the total protein present in the sample cut on 3rd January. As plants mature the fibrous material which is formed tends to imprison food constituents, so increasing the difficulty of digestion. This point should always be remembered in comparing the analytical values of young and old herbage.

It is not generally appreciated that young pasture is a rich foodstuff bearing comparison with concentrates for which the pastoralist will pay high prices. To emphasise the value of young pasture of the type obtained from the Buffel and Birdwood grass plots, Table II has been prepared. From this it can be seen that young Buffel grass may contain double the protein present in oat grain grown at Chapman or Wongan Hills, and one and a half times the protein present in F.A.Q. wheat. Not only does this young grass contain a high percentage of good quality protein but it is well balanced in other nutrients for stock.

It is very apparent that Buffel and Birdwood grasses are going to play an important part in the improvement of the Kimberley pastures. They provide good quality early feed and, if correctly managed, this quality can be maintained throughout the growing season. No figures are yet available regarding the weight of feed which is produced by a Buffel and Birdwood pasture in the Kimberleys, but in Northern Queensland test plots of Buffel Grass cut monthly to a height of 2 inches, yielded 3½ tons dry matter per acre per annum, this young material being very nutritious and containing, on an average, 12 per cent. crude protein. The material from similar plots which were cut every three months contained on average only 6 per cent. crude protein, illustrating once again the decline in quality which is seen in grasses as they mature.

Para (Brachiaria mutica) Table III.

Para is an introduced grass which has shown considerable promise, particularly as a source of early feed following the first rains. In the wet coastal belt of Northern Queensland Para has proved outstanding as a pasture grass for fattening cattle brought in from the drier areas, and it would be a valuable addition to the Kimberley pastures.

The Kimberley samples of Para were obtained from plots established under sprinkler irrigation in 1943. The plots were not watered in 1944 or 1945. Excellent growth was made with the first rains in November, 1944, Para providing the best feed available on the station. The sample cut for analysis on December, 13th, contained 10 per cent. crude protein compared with the 7 per cent. present in Buffel grass cut at the same time. It is interesting to note that all specimens of Para were rich in phosphate and lime, this plant being the only one of which all samples contained adequate amounts of these essential elements.

Six cuts of the grass on this plot were made between December 13th, and April 9th. It is probable that the frequent cutting was harmful to the plants and was partly responsible for their progressive decline. Sufficient time must elapse between cuttings so that the leaves can supply adequate nutrients to the roots to maintain the plant in full vigour. Para is a stemmy grass and it is said that cattle eat only the succulent leaves. It is evident from the high crude fibre content of the samples collected towards the end of the season at Ivanhoe, that much stemmy matter was included. This was unfair to the plant because it lowered the apparent feeding value, and the loss of the stem reduced the ability of the plant to recover from the cuttings.

Lack of nitrates in the soil was probably the important factor in the progressive decline of the Para grass, as shown in Table III. Rapidly growing grasses need generous supplies of nitrogenous constituents if productivity is to be maintained, especially in tropical regions where nutrients are often so readily leached from the soils by heavy rain. The most satisfactory way to supply pasture grasses with nitrates is to grow legumes in association with them. It is therefore very interesting to learn that, where Para has been grown in association with lucerne, a vigorous growth of healthy deep-green nutritious grass has been obtained, in contrast to the unthrifty pale-green herbage from Para growing in a pure stand. The analytical figures recorded in Table IV are very significant and indicate the great benefit which would result if a self-regenerating legume could be found which could be incorporated in the grass pastures of the tropics. As can be seen, Para grass growing with lucerne provided twice the amount of protein and a much heavier yield of more nutritious fodder.

Wherever irrigation is practicable it seems that Para and lucerne will form an excellent combination and much is anticipated from the success of this and similar mixtures. Once Para and lucerne plants have become established they may persist in the Kimberleys without irrigation and, with the early rains, would provide a considerable bulk of excellent fodder.

As an index of the carrying capacity of Para under good conditions, results obtained in the wet coastal belt of Northern Queensland may be quoted. Here a test area of 240 acres supported 100 head of cattle throughout the year. Four paddocks, each 60 acres, were grazed in turn for a period of three weeks. The quality of the pasture under this system of rotational grazing remained excellent, the protein ranging between 12 and 15 per cent. It is important to learn just what use can be made of Para in the Kimberleys.

Kangaroo Grass (Themeda triandra) Table V.

Kangaroo grass may be taken as typical of the indigenous perennial grasses which develop rapidly with the first rains, providing fair feed while young, but quickly becoming so rank and coarse as to be practically useless even for cattle. The analytical figures in Table V illustrate very well the quick maturity and rapid deterioration characteristic of these grasses.

The plots from which the samples were obtained were heavily grazed in December, the Kangaroo grass providing a good bulk of early feed. The area was never enclosed but the plants grew vigorously so that in a matter of weeks the grass was too coarse for use as stock feed.

For purposes of comparison, the analytical values of Kangaroo grasses grown in various part of South Africa are appended to Table V. The same poor quality herbage is evident, so it seems that kangaroo grass is naturally of low nutritive value. The low phophate and calcium content of the Kimberley samples suggests this possibility also, as they were grown on the same soil type as the Para, which was so rich in minerals. It seems that better grasses than Kangaroo grass should be encouraged.

Flinders Grass (Iseilema fragile) Table VI.

This grass may be taken as an example of the quick growing annuals which are considered quite good grasses bv the pastoralist, but which have the disadvantage of a comparatively short period during which they provide feed. As can be seen from the Table, the Flinders grass does not respond to the first rains as quickly as do perennials which already have a robust root stock awaiting the opportunity to develop. Admittedly the presence of grazing animals may have retarded the growth of young seedlings in December but it was not until mid January that the Flinders grass began to make headway. By the end of March the grass had seeded and become almost useless as a feed, which indicates a very short period of effective growth. As far as one can judge from the figures in Table VI, Flinders grass has little to recommend it and the data support the contention that perennials are essential if reasonable pastures are to be maintained in the Kimberley areas. It is probable that the decline in carrying capacity and the onset of erosion is in most cases associated with the replacement of the native perennials by annuals.

Sehima (Sehima nervosum) Table VII.

On portions of the black soils typical of the Ivanhoe plains, Sehima has become the dominant pasture grass, having replaced more useful perennials which have been less able to withstand stocking. Sehima does not make a great deal of growth during the early part of the season. It seems to conserve and consolidate its resources until feed is plentiful so that it does not suffer from overgrazing by hungry stock in December and January. This protective inactivity is said to be the main reason for the dominance of Sehima in the pastures today. During February and March the plants make rapid growth and quickly reach maturity. As far as one can judge from Table VII, Sehima herbage is of little value at any stage of growth, being very fibrous and a poor source of protein and minerals.

Because it is the major plant constituent of the pastures over extensive areas it may be necessary to work out methods of management which will utilise Sehima to the best advantage but apparently there are other perennials of much better quality which should be introduced as soon as is practicable.

Sugar Grass or Native Sorghum (Sorghum plumosum) Table VIII.

The native sorghums are robust annuals which provide some early feed and then make such vigorous growth that the tall canes soon become useless to stock, except for short watery shoots which grow from the nodes. As far as one can judge, this plant as a fodder grass has little to recommend it—it provides significant quantities of food for only a short period of the rainy season, and the nutritive value of the samples collected were very low. It seems unlikely that native sorghums will withstand repeated cutting and it is obvious that the plants are of little value if left to mature. Perhaps some system of management may be devised which can turn to advantage the vigor of this bulky plant but meanwhile the pastoralist seems advised to make maximum use of more easily utilised species.

Nigger-head (Enneapogan polyphyllus) Table IX.

Nigger-head is considered quite a useful grass by pastoralists, as it supplies green feed over an extended period and it is useful in the reclaimation of scoured ground. As can be seen from Table IX Nigger-head provided feed of a reasonable quality over a much longer period than many other natural grasses. The high figures for crude fibre suggest that considerable inedible material was included in the samples cut for analysis. This being so, one could assume that cattle would obtain herbage of considerably higher nutritive value by selective grazing.

It seems that Nigger-head is one of the useful grasses well worth further study, especially as it may play an important role in the building up of depleted soils.

Native Couch (Brachyachne convergens) Table X.

Native couch provides good feed over a short period but it is another of the short term annuals which should be replaced by perennials. This grass provides no cover for the soil during the dry months, and ground so exposed may become "scalded." The samples of native couch analysed were remarkably deficient in minerals.

Bunch Spear Grass (Heteropogon contortus) Table XI.

Because of its savage seed-head this grass, when mature, is disliked by man and beast. While young, however, it provides quite useful early feed following the first rains, and heavy stocking during this period should give some measure of control of a grass which has nothing else to recommend it.

GENERAL DISCUSSION.

Protein.

As can be seen from the various Tables in this paper, the herbage available to stock in the Kimberleys during the long dry winter, is very deficient in protein. The mature herbage from even the best grasses contains only about 4-5 per cent. crude protein while the poorer species may contain no more than 1-2 per cent. for many months of the year. Not only is the dry herbage very deficient in total protein but this protein is of little use to the grazing animal because of its low digestibility. In young grass, such as the sample of Buffel-Birdwood grass containing 16 per cent. protein, about 80 per cent. of this protein can be used by the animal. When the plant matures and the protein drops to about 6 per cent. it is doubtful if half of this can be used by the animal: if the protein drops to 3 per cent. or less it is considered that none is of any use (White, 1940).

The grazing animal, by selecting seeds, seedheads, young shoots and topfeed, probably obtains a diet richer in protein than the figures in the Tables would imply, but even so, months of selective grazing and continued weathering must reduce the quality of the pasture to a very low status in the months preceding the summer rains.

Possible methods by which the protein intake of Kimberley cattle may be raised are:—

1. Introduction of a pastoral legume.
2. Cutting natural herbage when it contains adequate protein and conserving it for use during the months of scarcity.
3. Establishing perennials which prolong the period during which nutritious feed is available.

Introducing a legume.

Most countries with tropical or subtropical pastoral areas have been seeking a legume which will do for them what sub-clover has done for southern Australia, but to-date the search has been unavailing. Plants which have shown promise elsewhere are even now being tried in the Kimberleys but success has still to be proved. Lucerne does very well but as it is essentially a cultivated plant it cannot be used for the improvement of extensive natural pastures. There is every hope, however, that lucerne will play a very important role as a component of irrigated pastures and in due course lucerne hay may be available in considerable quantities. But a pastoral legume which will become widespread in the natural pastures of the tropics has yet to be found.

Cutting Natural Herbage.

The control of pastures by periodic intensive grazing and/or mowing has resulted in marked increases in carrying capacity wherever it has been adopted. Even when the herbage has been cut only once or twice during the growing season, the results have often been spectacular. As an illustration of the value of hay-making in pastoral country, the results obtained in Queensland on Mitchell grass country can be quoted (Davies et. al. 1938). The natural pasture normally carried one sheep to four acres but it was found that the hay cut in one month (April) provided sufficient food to support the equivalent of two sheep per acre all the year. Results such as these show that when grass is allowed to mature, the bulk of the herbage is in fact wasted.

It would be very interesting to determine the value of the hay obtainable by repeated cutting of selected Kimberley pastures during the growing season. Much would depend on the response of the native species; some would doubtless lose their vigour but if they were in due course replaced by better types such as Buffel or Birdwood grass, so much the better.

It is hoped that some form of pick-up baler will be adapted for use in harvesting hay in the northern areas. The economic use of such labour-saving machinery might do much to revolutionise live-stock husbandry in the Kimberleys, and the practical problems associated with such developments warrant immediate attention.

Establishing Perennials.

The efficient use of permanent perennial pastures requires the development of some system of rotational grazing and/or cutting of the herbage, which in turn requires the outlay of considerable capital in fencing, machinery and water-

supplies. It is possible that such a system may be gradually built up to perfection, first by the use of machinery to cut the excess growth on the natural pastures, then by the gradual introduction of better quality plant species, and eventually by the use of small paddocks (with or without irrigation) which can be subjected to intensive rotational grazing. Just how all this can be achieved has yet to be determined but only by some such system of progressive agriculture can the Kimberleys be expected to support a prosperous rural community of any permanence.

MINERAL CONSTITUENTS.

Phosphorus.

When Sir Arnold Theiler, who did so much of the pioneer work which showed the importance of phosphatic supplements to South African veld cattle, visited this State he reported that the Kimberley cattle he saw showed characteristic symptoms of phosphorus deficiency. As these cattle are required to subsist for six months or more on mature grass which is characteristically deficient in phosphorus, it was then accepted that lack of this essential element was probably a major factor limiting the well-being of stock in these areas. Of recent years the emphasis has shifted from phosphorus deficiency to the lack of other constituents such as protein, but it is well to remember that phosphorus continues to be a prime necessity to growing and lactating animals.

As a basis for discussion it can be taken that a pasture should provide at least 0.20 per cent. P in the part that is eaten by the animal. Very few of the samples discussed in this paper supply this desired minimum and it is important to consider possible causes and effects.

A pasture may be lacking in phosphate because the soil on which it is growing is deficient, or because the plants of which it is composed do not normally assimilate a great deal of phosphorus, or because the samples are collected at a stage of growth when the plants have a minimum phosphorus content.

In large areas of Western Australia the soils are notoriously deficient in useful phosphates and such data as are available suggest that the Kimberley soils are also lacking in this element. To date, however, dressings of superphosphate have not given any appreciable increases in yields and it seems that other deficiencies are equally important limiting factors. Plant species such as Buffel, Birdwood, and Para grasses were able to obtain adequate supplies of phosphate; this suggests that the low percentage found in other species is a natural characteristic. This brings one to the second possibility, namely, that grasses such as Kangaroo, Flinders and Sehima, do not absorb a great deal of phosphorus and are therefore poor sources of the element for the grazing animal. If such is the case, this supplies yet another reason for improving the pasture by concentrating on the more desirable species.

The phosphate content of a pasture varies considerably with the age of the component plants. Young Buffel grass may contain 0.3 per cent. P in the dry matter, whereas the mature plant may contain only 0.06 per cent. Unfortunately many of the plants grown at Ivanhoe were deficient in phosphorus at *all* stages of growth, particularly so when mature. Thus Flinders grass in flower contained only 0.11 per cent P and Sehima just coming into flower contained only 0.08 per cent. Contrast these low figures with the 0.25 per cent P present in Buffel grass at the pre-flowering stage, or with Para which showed a maximum value of 0.45 per cent. and a minimum of 0.26 per cent P.

The presence of a certain proportion of edible plants having a high phosphate content can do much to redeem the deficiencies of the bulk of the herbage. Shrubs and various types of "topfeed" are characteristically rich in phosphorus and where stock have access to these, no evidence of deficiency may be apparent even after long periods on otherwise dry pasture. Legumes are rich in phosphorus, as also are most seeds. Again, certain classes of stock, particularly sheep, can persist for a long period on rations low in phosphorus, so long as the pasture during the "flush" is rich in this element. Cattle, however, are more sensitive to lack of phosphate in the diet, especially if pregnant or lactating. It so happens that the Kimberley breeding cows carry their calves during the major portion of the dry months and phosphorus deficiency must be a factor accentuating the general undernourishment. For this reason it seems important in the Kimberleys to encourage the growth of plants rich in phosphorus and, if possible, to conserve herbage cut when the phosphorus content is at a peak. Fortunately it so happens that any steps taken to increase the protein content of the herbage will also lead to an increase in available phosphorus.

Calcium.

Western Australian pastures generally contain adequate calcium or lime for the needs of grazing animals. Some of the Kimberley samples, particularly the native sorghums, were somewhat deficient in this essential element but it seems very unlikely that stock on mixed pasture would be handicapped in any way by a lack of lime. The growth rate and milk flow of Kimberley cattle is most likely to be limited by lack of protein and phosphorus, and even by lack of energy-producing food during the latter part of the dry season.

Minor Elements.

All stock breeders are now familiar with the important role played by the so-called "trace" elements. The use of comparatively small amounts of copper, for example, has eliminated serious and costly stock ailments over large areas of country in Western Australia alone. If the Kimberleys are to be developed on anything like an extensive scale it is therefore important to anticipate, if possible, the likelihood of trace element deficiencies in the pastures.

Samples of the various grasses collected at Ivanhoe about flowering time, were therefore analysed to show the copper, cobalt, zinc and manganese contents, these minerals being among those now known to be of importance in nutrition. The results are recorded in Table XII. The figures for a "standard" good quality pasture have been appended to the foot of the Table for comparative purposes.

The amounts of the essential elements present in the various samples vary considerably. Further samples will need to be analysed to confirm the marked variation seen between the species but it is satisfactory to note that the "good" quality grasses such as Buffel, Birdwood and Para, supply adequate amounts of the trace elements under consideration. The less desirable grasses such as Kangaroo, Sehima and Bunch Spear grass are in most cases seriously deficient in essential elements but it seems that so long as the animals can graze on mixed pastures, there is no obvious danger of trace element deficiencies affecting the well-being of the stock. For example, the native sorghums are rich in Zn but very deficient in Co, whereas native couch is just the reverse. Either grass alone would not suffice but together the mixture would supply ample of the two elements mentioned. The value of a varied diet has always been stressed by good husbandry-men and this simple example illustrates very well the virtues of a mixed pasture. As far as one can judge from Table XII it seems that alluvial "Ord sandy loam"

will grow good quality pasture free from obvious trace element deficiencies but we should remember that other soil types in the Kimberleys may not be so productive of 'complete' pastures. In fact, the low values for copper and cobalt seen in some of the indigenous species of pasture plant, arouse the suspicion that deficient areas may occur. Further studies may prove very interesting, if only to achieve an explanation for the surprising low copper and cobalt values found in some of the native plants.

Vitamin A.

No Vitamin A determinations were made on any of the Kimberley pastoral samples but dry natural pastures are characteristically deficient in this essential nutrient. Lack of this vitamin can cause sterility in sheep and cattle before there is any evidence that the general health is affected. In the Kimberleys cattle will not mate until a month or so following the growth of green feed. This means that the calves are dropped towards the end of the following dry period, which places maximum strain on the pregnant cow and jeopardises the survival of the calf. Supplies of meadow hay, cured so as to give maximum conservation of Vitamin A, would do much to minimise the evils of this system, firstly by supplying nutrients about the time of calving, and secondly, by giving the pastoralist a means to induce mating by supplementary feeding and so possibly to change the calving date to a more favoured time of the year.

SUMMARY.

Serial samples of grasses growing under natural conditions at Ivanhoe Station on the Ord River in the Kimberleys, North West Australia, were collected during the growing season and analysed to show the crude protein, crude fibre, phosphate and calcium content.

A sample of each species, collected about the flowering stage, was further analysed to show the copper, cobalt, zinc and manganese content.

The quality of the herbage varied considerably between species, and within the species according to the stage of growth.

The best fodder was obtained from a mixture of Buffel and Birdwood grasses, which supplied a considerable bulk of nutritious herbage throughout the wet season. When kept young by rotational grazing or cutting, the Buffel-Birdwood mixture produced herbage with 14-16 per cent. crude protein in the dry matter, and adequate supplies of all the minerals examined.

In contrast, native perennials (Kangaroo Grass, Sehima) and native annuals (Flinders grass, native sorghum) supplied useful fodder over only a short period, the food value of this fodder was never very high, and the mature growth was mostly useless as a stockfeed.

Under the present system livestock must subsist for most of the dry period on a diet deficient in protein, as the best quality dry grasses contain only 3-5 per cent, crude protein in the dry matter and the bulk of the dry herbage contains as little as 1-3 per cent.

Some of the native perennials are deficient in minerals but the better quality plants apparently supply adequate amounts of all the essentials examined, at least during the growing period.

On the evidence available it seems that the obvious deficiencies occurring in the Kimberley pastures may be corrected by the extended use of the better quality plants, and the introduction of methods of controlled grazing and fodder conservation.

An investigation of methods of cutting and conserving green pasture for use during the long dry period is urgently needed.

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TABLE I.

MIXTURE:—*Buffel and Birdwood Grass (Cenchrus ciliaris and C. setigerus).*

Grown on Ord Sandy Loam (Red alluvial).

Percentage composition on dry weight basis.

Sample No.	Date Collected.	Nature of Sample.	Crude Protein N x 6·25.	Crude Fibre.	Phosphorus P.	Calcium Ca.
			%	%	%	%
1	13–12–44	Good quality bulky pasture, mostly young growth following heavy grazing	7·1	31	·12	·40
2	3–1–45	From area burnt on 13th December. 1½–3ft. high, advanced flowering	14·3	27	·18	·38
3	22–1–45	Mature seed stage	9·4	33	·16	·27
4	20–2–45	Very mature. Much seed has fallen	5·5	36	·14	·21
5	7–3–45	Pre-flowering stage. From area grazed once and mown once	15·7	28	·29	·36
6	23–3–45	Mature grass (not cut when sample No. 5 was collected)	8·1	36	·25	·30
7	9–4–45	Sample represent two weeks growth after removal of stock	16·0	26	·21	·28
8	25–4–45	As for No. 7, one month after removal of stock	13·9	31	·32	·27
9	13–5–45	Mature grass not wholly dry. Seed fallen	3·6	32	·10	·34
10	5–7–45	Dry mature grass. Seed fallen	4·7	33	·06	·31
11	5–8–45	Dry mature grass. Seed fallen	5·3	32	·07	·33
12	1–10–45	Dry mature grass. Seed fallen	5·9	34	·09	·30

TABLE II.

Value of Young Pasture.

Comparative Figures.

Percentage Composition on Dry Weight Basis

Foodstuff.	Crude Protein. N × 6·25	Crude Fibre.	Phospherous as P	Calcium as Ca.
	%	%	%	%
Buffel and Birdwood Grass cut 7th March, in pre-flowering stage	16	28	·29	·36
Oaten Hay—average of 36 samples grown at Merredin, W.A.	5	28	·12	·06
W. Aust. F.A.Q. wheat grain. Average of 7 years	11	3	·24	·04
Oat grain grown at Wongan Hills. Average of 5 years	8·5	12	·20	·06
Oat grain grown at Chapman. Average of 5 years	8·5	12	·27	·07
Young subterranean clover grown at Harvey, W.A. Cut 22nd August	21	20	·30	·84

TABLE III.

Para (Brachiaria mutica Forsk) Stapl.

Grown on Ord Sandy Loam (Red Alluvial).

Percentage Composition on Dry Matter Basis

Sample No.	Date Collected.	Nature of Sample.	Crude Protein N x 6·25	Crude Fibre.	Phosphorus P	Calcium Ca.
			%	%	%	%
1	13–12–44	Growth made in week following rains. (This grass providing best feed available at time of cutting)	9·5	30	·26	·69
2	3–1–45	Regrowth following cutting of sample 1	8·8	31	·43	·54
3	22–1–45	Regrowth following cutting of sample 2	6·8	32	·44	·46
4	20–2–45	Regrowth following cutting of sample 3	5·2	36	·30	·46
5	7–3–45	Regrowth following cutting of sample 4. Grass beginning to show lack of vigour	5·2	35	·45	·35
6	23–3–45	Regrowth following cutting of sample 5	5·1	49	·27	·41
7	9–4–45	Regrowth following cutting of sample 6	5·1	52	·26	·47
8	25–4–45	No sample taken as growth very poor	...	...	...	...

General.—This plot of grass was established by sprinkler irrigation early in 1943. Was not watered in 1944 or 1945.

TABLE IV.

Para Grown Alone and with Lucerne. Irrigated.

Para Grass.	Age of Plants	Colour of Leaves	Composition as percentage of dry matter.				Relative Yield.
			Crude Protein N x 6·25	Crude Fibre.	Ca	P	
A. grown with lucerne	6 months	Deep green	12·5	31	·27	·29	10
B. grown alone	6 months	Pale green	6·2	32	·18	·30	6
C. grown alone	25 months	Very pale green	3·6	33	·30	·29	2

A. and B. cut monthly. Sample regrowth of one month. C. grazed until three months before sampling.

TABLE V.

Kangaroo Grass (Themeda triandra) Forsk.

Grown on Ord Sandy Loam.

Percentage Composition on Dry Matter Basis.

Sample No.	Date Collected.	Nature of Sample.	Crude Protein N x 6·25.	Crude Fibre.	Phosphorus P.	Calcium Ca.
			%	%	%	%
1	19–1–45	Vigorous growth following removal of stock on December 30. Plants in pre-flowering stage and already too coarse for stock	5·8	36	·18	·30
2	18–2–45	5 ft. high. In flower	3·4	42	·11	·21
3	15–3–45	Past flowering stage	4·2	39	·12	·26
4	30–3–45	Mature grass still green	3·2	38	·12	·28
5	13–4–45	Mature grass drying off	2·6	38	·11	·30
6	12–5–45	Fairly dry	2·6	37	·13	·31
7	5–7–45	Quite dry	1·4	40	·12	·32
8	5–8–45	Quite dry	1·0	41	·09	·29
9	3–10–45	Quite dry	1·2	41	·12	·22
		Average	2·9	...	·07	·23
		Range 13 samples of Kangaroo Grass, green but mainly mature, collected in Union of South Africa, 1931.	2·0–5·0	...	·04–·13	·17–·32

TABLE VI.

Flinders Grass (Iseilema fragile) S. T. Blake.

Grown on Cununurra Clay (heavy black soil).

Percentage composition on Dry Matter Basis.

Sample No.	Collected.	Nature of Sample.	Crude Protein N x 6·25	Crude Fibre.	Phosphorus P	Calcium Ca.
			%	%	%	%
1	1-1-45	No sign of this grass—plot had been grazed	...	...	...	...
2	19-1-45	Grass showing, following enclosure	...	...	...	...
3	18-2-45	Grass in flower—about 2ft. high	4·5	38	·11	·25
4	15-3-45	Just past flowering stage	2·5	38	·10	·24
5	30-3-45	Mature—drying off	2·3	38	·10	·26
6	13-4-45	Amost dry	2·3	38	·10	·24
7	12-5-45	Quite dry	2·0	38	·09	·20
8	5-7-45	Quite dry	1·5	37	·07	·22
9	5-8-45	Quite dry	1·3	36	·08	·17
10	5-8-45	Quite dry	3·0	36	·08	·17
11	3-10-45	Quite dry—sheaf prepared of grass 18-24ins. high. Seed had fallen ...	1·6	39	·09	·23

TABLE VII.

Sehima (Sehima nervosum) (Rotth.) Stapf.

Grown on Cununurra Clay.

Percentage Composition on Dry Matter Basis.

Sample No.	Date Collected.	Nature of Sample. Sehima is the dominant grass in the Ivanhoe black soil pastures.	Crude Protein N x 6·25.	Crude Fibre.	Phosphorus P.	Calcium Ca.
			%	%	%	%
1	13–12–44	No evidence of growth	...	...	...	...
2	17–12–44	Fair shoot among old stools	...	...	...	...
3	1–1–45	Good releif feed among old stools	...	...	...	...
4	19–1–45	Area enclosed on 1st January, and adjacent ares, not worth sampling ...	...	...	...	...
5	22–2–45	3ft. 6in. high and just coming into flower	4·6	40	·08	·46
6	9–3–45	Up to 5ft. high. In flower	4·1	42	·06	·34
7	23–3–45	Mature grass quite green	4·1	39	·06	·40
8	9–4–45	Mature grass —still green	3·4	40	·05	·43
9	25–4–45	Mature grass. Seed fallen from first heads but fresh heads forming ...	3·1	40	·06	·37
10	5–7–45	Quite dry	1·7	39	·03	·42
11	5–8–45	Quite dry	1·1	34	·02	·38
12	1–10–45	Quite dry. White lower leaves selected	1·4	37	·02	·45

TABLE VIII.

Sugar Grass or Native Sorghum (S. plumosum (R.Bo.) Beauv.).

Grown on Ord Sandy Loam.

Percentage Composition on Dry Matter Basis.

Sample No.	Date Collected.	Nature of Sample.	Crude Protein N x 6·25.	Crude Fibre.	Phosphorus P.	Calcium Ca.
			%	%	%	%
1	13–12–44	Germinated with first rains but eaten out by stock and grasshoppers ...	...	...	...	...
2	1–1–45	Stock still keeping pasture very low	...	...	...	...
3	19–1–45	Remarkable growth following rains and removal of stock three weeks previously	4·2	32	·26	·39
4	18–2–45	Grass up to 6ft. high. Not in flower	4·2	40	·15	·24
5	15–3–45	Over 8ft. high and fully in flower	4·2	32	·23	·17
6	30–3–45	Drying off	2·3	43	·15	·13
7	13–4–45	Half dry	2·3	43	·15	·13
8	12–5–45	Almost dry	1·3	42	·16	·12
9	5–7–45	Quite dry—very little flag	0·9	46	·17	·12
10	5–8–45	Quite dry—no flag	0·9	46	·18	·10

TABLE IX.

Nigger Head (Enneapogan polyphyllus) (Domin), N. T. Burbidge.

Grown on Ord Sandy Loam.

Percentage Composition on Dry Matter Basis.

Sample No.	Date Collected.	Nature of Sample.	Crude Protein N x 6·25.	Crude Fibre.	Phosphorus P.	Calcium Ca.
			%	%	%	%
1	13–12–44	Sample not taken. Growth sparse among dense mass of old stems. Area burnt	...	...	...	...
2	3–1–45	Sample taken from unburnt area as burning killed old plants	10·8	38	·23	·71
3	22–1–45	Sample taken adjacent to 2. Flowering	9·1	39	·18	·59
4	20–2–45	Mature grass starting to dry off. Seed falling	6·7	41	·12	·48
5	7–3–45	Sample from seedlings growing on burnt area. Seems poorer species of grass	4·6	41	·22	·30
6	23–3–45	Same type as 5. Mature grass drying off	7·8	41	·12	·26
7	9–4–45	Regrowth from area 2, 3 and 4. Well in flower	4·4	40	·18	·46
8	25–4–45	From area 7. Still quite green and in good condition	6·8	48	·11	·56
9	13–5–45	From area 7. Still green and in good condition	2·9	39	·14	·44
10	5–7–45	From area 7. Still fairly green and in good condition	3·1	38	·15	·67
11	5–8–45	From area 7. Not wholly dry	4·3	39	·15	·61
12	1–10–45	Dry, seed dropped. Leafy type about 1ft. tall	2·9	38	·15	·41
13	1–10–45	Dry, seed dropped. Erect and non-leafy type	2·4	35	·08	·27

TABLE X.

Native Couch (Brachyachne convergens (F. Muell.) Stapf.

Grown on Ord Sandy Loam.

Percentage Composition on Dry Matter Basis.

Sample No.	Date Collected.	Nature of Sample.	Crude Protein N x 6·25	Crude Fibre.	Phosphorus P	Calcium Ca.
			%	%	%	%
	13–12–44	No germination apparent	...	...	...	...
	17–12–44	Heavy germination. Providing feed but not sampled	...	...	...	...
1	19–1–45	Well in flower. Plants made remarkable growth in three weeks following removal of stock	12·9	33	·25	·46
2	18–2–45	Grass drying off. Much seed has fallen	5·4	34	·08	·31
3	15–3–45	Grass in good condition with much fresh growth	8·1	36	·10	·32
4	30–3–45	Grass drying	4·9	36	·08	·29
5	13–4–45	Almost dry	5·6	36	·07	·31
6	13–5–45	Dry grass	4·8	35	·07	·36
7	5–7–45	Dry grass from protected enclosure	3·5	33	·21	·35
8	5–8–45	Dry grass	3·5	33	·20	·35
9	1–10–45	Dry plants about 1 ft. high ; seed largely fallen	7·9	43	·03	·47

TABLE XI.

Bunch Spear Grass (Heteropogon contortus) (L.) Beauv. ex R. & S.

Grown on Ord Sandy Loam.

Percentage Composition on Dry Matter Basis.

Sample No.	Date Collected.	Nature of Sample.	Crude Protein N x 6·25	Crude Fibre.	Phosphorus P	Calcium Ca.
...	...	This grass produced much very early feed of great value and area was heavily stocked until 5th January	% ...	% ...	% ...	% ...
1	19–1–45	Grass progressed well after removal of stock	7·6	36	·13	·23
2	18–2–45	Up to 4ft. 6in. high ; coming into flower	3·2	42	·07	·16
3	15–3–45	Up to 4ft. 6in. high ; in flower. Seed not formed	3·0	42	·07	·11
4	30–3–45	Mature grass but quite green	2·7	42	·07	·14
5	13–4–45	Mature but green	3·1	38	·08	·18
6	12–5–45	Fairly dry. Seed fallen	1·9	38	·11	·25
7	5–7–45	Almost dry	1·4	41	·06	·22
8	5–8–45	Fairly green sample	1·1	37	·07	·36
9	3–10–45	Mostly dry. Seeds dropped	0·9	37	·05	·34

TABLE XII.

Minor Elements in Pasture Samples, Ivanhoe Area, Kimberleys.

Date Collected.	Species.	Composition—percentage dry matter							Parts per million in dry matter.				Soil Type.
		Nitrogen N.	Crude Protein. N x 6·25	Crude Fibre.	Phosphorus P.	Calcium Ca.	Potassium. K	Magnesium. Mg.	Copper Cu.	Maganese. Mn.	Zinc Zn.	Cobalt Co.	
3–1–45	Buffel and Birdwood grass	2·29	14·3	27	·18	·38	3·31	·26	9·8	64	46	·20	Ord sandy loam.
13–12–44	Para	1·52	9·5	30	·26	·69	2·42	·38	11·9	112	80	·56	Ord sandy loam.
18–2–45	Kangaroo grass...	·54	3·4	42	·11	·21	·83	·10	3·2	56	27	·03	Ord sand loam.
18–2–45	Flinders grass ...	·72	4·5	38	·11	·25	1·67	·23	3·7	44	51	·14	Cunnunurra Clay.
9–3–45	Sehima	·65	4·2	42	·06	·34	·78	·11	2·9	18	32	·09	Cunnunurra Clay.
15–3–45	Native Sorghum	·67	4·2	32	·23	·17	1·22	·18	4·5	34	81	·03	Ord sandy loam.
22–1–45	Nigger-head ...	1·46	9·1	39	·18	·59	1·53	·21	7·3	45	19	·21	Ord sandy loam.
19–1–45	Native Couch ...	2·07	13·0	33	·25	·46	2·25	·33	7·1	86	21	·13	Ord sandy loam.
15–3–45	Bunch Spear Grass	48	3·0	42	·07	·11	·92	·14	3·0	74	31	·07	Ord sandy loam.
For Comparison	Good quality Mixed pasture	2·56	16·0	23	·3	·7	2·5	...	9	50	40	·12	

Fertilisers.

The following fertilisers have been registered at the Department of Agriculture under the Fertiliser Act, 1928, for the year commencing 1st November, 1946:—

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered.	Nitrogen (N) as				Phosphoric Acid (P_2O_5) as				Potash (K_2O) as		Cash Price per ton on rails at Works† or Perth.‡
				Nitrate.	Ammonia.	Blood and Bone	Bone-dust.	Water sol.	Citrate sol.	Acid sol.	Total.	Sulphate.	Muriate.	
				%	%	%	%	%	%	%	%	%	%	£ s. d.
A.—MINERAL.														
1.—NITROGENOUS.														
(a) *Nitrogen as Nitrate*—														
Nitrate of Soda	11	Cresco	Cresco Fertilisers, Ltd.	15·50	....	....	....	....	....	....	....	....	....	18 10 0†
	18	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	15·50	....	....	....	....	....	....	....	....	....	18 10 0†
	30	ML in diamond....	do. do.	15·50	....	....	....	....	....	....	....	....	....	18 10 0†
	37	Sickle	do. do.	15·50	....	....	....	....	....	....	....	....	....	18 10 0†
	51	Faulding's	F. H. Faulding & Co.	16·00	....	....	....	....	....	....	....	....	....	37/4 per cwt. ‡
	55	Champion	R. Dundas Smith & Son	16·00	....	....	....	....	....	....	....	....	....	*
(b) *Nitrogen as Ammonia*—														
Sulphate of Ammonia	12	Cresco	Cresco Fertilisers, Ltd.	....	20·50	....	....	....	....	....	....	....	....	18 10 0†
	45	Elephant....	Cuming Smith & Mt. Lyell F.F., Ltd.	....	20·50	....	....	....	....	....	....	....	....	18 10 0†
	52	Faulding's	F. H. Faulding & Co.	....	20·00	....	....	....	....	....	....	....	....	32/8 per cwt.‡
	53	do.	do. do.	30·00		....	....	....	....	....	....	....	....	65/4 per cwt.‡
2.—PHOSPHATIC.														
(a) *Rock Phosphate*—														
Phosphate Powder	15	Cresco	Cresco Fertilisers, Ltd.	....	....	....	....	....	....	....	27·50	....	....	7 8 6†
(b) *Superphosphate*	5	Cresco	Cresco Fertilisers, Ltd.	....	....	....	....	14·00	2·50	1·50	18·00	....	....	5 3 6†
	6	do.	do. do.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
	19	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
	31	ML in diamond....	do. do.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
	38	Sickle	do. do.	....	....	....	....	15·00	2·50	1·50	19·00	....	....	5 8 6†
(c) *Rock Phosphate and Superphosphate*—														
50/50 Phosphate	16	Cresco	Cresco Fertilisers, Ltd.	....	....	....	....	7·00	1·50	13·50	22·00	....	....	6 16 0†
3.—POTASSIC.														
(a) Sulphate of Potash	13	Cresco	Cresco Fertilisers, Ltd.	....	....	....	....	....	....	....	....	30·00	....	16 13 0†
	20	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	....	....	....	....	....	....	....	30·00	....	16 13 0†
	65	Chandler	State (W.A.) Alunite Industry	....	....	....	....	....	....	....	....	30·00	....	8/10·7 per unit.†
(b) *Muriate of Potash*	14	Cresco	Cresco Fertilisers, Ltd.	....	....	....	....	....	....	....	....	60·0	....	29 175†
	21	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	....	....	....	....	....	....	....	60·00	....	29 17 5†

FERTILISERS.—*continued.*

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered.	Nitrogen (N) as				Phosphoric Acid (P_2O_5) as				Potash (K_2O)		Cash Price per ton on rails† at Works‡ or Perth.
				Nitrate.	Ammonia.	Blood and Bone	Bone-dust.	Water sol.	Citrate sol.	Acid sol.	Total.	Sulphate.	Muriate.	
				%	%	%	%	%	%	%	%	%	%	£ s. d.
(*b*) *Muriate of Potash*	32	ML in diamond	Cuming Smith & Mt. Lyell F. F., Ltd.	....	....	....	....	....	....	....	....	60·00	....	29 17 5†
	39	Sickle	do. do.	....	....	....	....	....	....	....	....	60·00	....	29 17 5†
4.—NITROGEN AND PHOSPHORIC ACID														
Potato Manure "C"	9	Cresco	Cresco Fertilisers, Ltd.	....	3·50	....	....	11·75	2·00	1·50	15·25	....	....	8 9 10†
Do. "C"	22	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	3·50	....	....	11·75	2·00	1·50	15·25	....	....	8 9 10†
Do. No. 2	33	ML in diamond	do. do.	....	3·50	....	....	11·75	2·00	1·50	15·25	....	....	8 9 10†
Do. "C"	40	Sickle	do. do.	....	3·50	....	....	11·75	2·00	1·50	15·25	....	....	8 9 10†
5.—NITROGEN PHOSPHORIC ACID AND POTASH.														
Potato Manure "A"	8	Cresco	Cresco Fertilisers, Ltd.	....	2·50	....	....	10·00	1·75	1·25	13·00	5·00	....	9 16 11†
Do. "A"	23	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	2·50	....	....	10·00	1·75	1·25	13·00	5·00	....	9 16 11†
Do. "B"	24	do.	do. do.	....	3·50	....	....	9·50	1·50	1·25	12·25	5·00	....	10 9 3†
Do. "A"	34	ML in diamond	do. do.	....	2·50	....	....	10·00	1·75	1·25	13·00	5·00	....	9 16 11†
Do. No. 3	35	do.	do. do.	....	3·50	....	....	9·50	1·50	1·25	12·25	5·00	....	10 9 3†
Do. "A"	41	Sickle	do. do.	....	2·50	....	....	10·00	1·75	1·25	13·00	5·00	....	9 16 11†
Do. "B"	42	do.	do. do.	....	3·50	....	....	9·50	1·50	1·25	12·25	5·00	....	10 9 3†
Do. "B"	57	Cresco	Cresco Fertilisers, Ltd.	....	3·50	....	....	9·50	1·50	1·25	12·25	5·00	....	10 9 3†
Orchard Manure	10	do.	do. do.	5·00	....	....	....	7·50	1·25	·75	9·50		9·80	14 9 9†
Do.	27	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	5·00	....	....	....	7·50	1·25	·75	9·50	....	9·80	14 9 9†
Do.	36	ML in diamond	do. do.	5·00	....	....	....	7·50	1·25	·75	9·50	....	9·80	14 9 9†
Do.	43	Sickle	do. do.	5·00	....	....	....	7·50	1·25	·75	9·50	....	9·80	14 9 9†
Do. No. 2	59	ML in diamond	do. do.	5·00	....	....	....	7·00	1·25	·75	9·00	5·00	....	12 5 8†
Do. No. 2	60	C.S.M.L.	do. do.	5·00	....	....	....	7·00	1·25	·75	....	5·00	....	12 5 8†
Do. No. 2	61	Sickle	do. do.	5·00	....	....	....	7·00	1·25	·75	....	5·00	....	12 5 8†
Tomato Manure	25	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	3·50	....	....	10·00	1·50	1·25	12·75	....	8·00	11 10 8†
Do. No. 2	63	do.	do. do.	....	3·50	....	....	6·00	·75	·75	7·50	12·00	....	13 5 0†
Tobacco Manure No. 5	26	do.	do. do.	2·80		....	....	11·25	1·75	1·35	14·35	2·50	....	9 2 8†
Liquid Manure	50	Faulding's	F. H. Faulding & Co.	....	7·50	....	....	....	....	....	5·00	3·50§		3s. per pint bottle.‖
6.—SUPERPHOSPHATE AND COPPER.												Copper Oxide.		
Super. and Copper	7	Cresco	Cresco Fertiliser, Ltd.	....	....	....	....	13·00	2·50	1·50	17·00	1·25		8 3 10†
Super. and Copper Ore	28	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	....	....	....	12·30	2·00	1·50	15·80	1·60		7 8 11†

§As Caustic Potash. ‖Price at Works, Sydney.

FERTILISERS—*continued.*

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered.	Nitrogen (N) as Nitrate.	Nitrogen (N) as Ammonia.	Nitrogen (N) as Blood and Bone	Nitrogen (N) as Bone-dust.	Phosphoric Acid (P_2O_5) as Water sol.	Phosphoric Acid (P_2O_5) as Citrate sol.	Phosphoric Acid (P_2O_5) as Acid sol.	Phosphoric Acid (P_2O_5) as Total.	Potash (K_2O) Sulphate.	Potash (K_2O) Muriate.	Cash Price per ton on rails Works † or Perth. ‡
				%	%	%	%	%	%	%	%	%	%	£ s. d.
Super. and Copper Ore	44	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.	....	....	....	....	12·30	2·00	1·50	15·80		1·60	7 8 11†
Super. and Copper No. 1	62	C.S.M.L.	do. do.	....	....	....	....	14·00	2·50	1·50	18·00	....	....	8 10 4†
B.—ORGANIC.														
(*a*) *Animal Fertiliser.*														
Animal Fertiliser	3	State Abattoirs, Midland Junct.	State Abattoirs, Midland Junction	....	....	8·00	....	....	....	5·00	5·00	....	....	9 5 0†
Blood and Bone	2	DBG in diamond	W. Angliss & Co. (Aust.) Pty., Ltd.	....	....	6·00	....	....	8·00	4·00	12·00	....	....	10 12 6‖
Blood and Bone	4	Wyndham	Wyndham Freezing, Canning Meat Export Works	....	....	5·75	....	....	6·00	9·00	15·00	....	....	10 12 6‡
Do.	29	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	....	....	5·00	....	....	....	15·00	15·00	....	....	10 10 0†
Blood, Bone, and Offal	1	Riverstone	W. Angliss & Co. (Aust.) Pty., Ltd.	....	....	5·50	....	....	9·25	5·00	14·25	....	....	7 15 0‖
Blood and Bone	46	A. and A. Surprise	C. A. Kirkby & Son	....	....	5·50	....	....	4·00	10·00	14·00	....	....	14 5 0‡
Do.	47	Albany Freezing Work	West Australian Meat Export Works	....	....	6·00	....	....	....	....	12·00	....	....	10 0 0†
Do.	48	Eclipse	do. do.	....	....	6·00	....	....	....	12·00	12·00	....	....	10 9 3†
Do.	49	Robb's	do. do.	....	....	5·25	....	....	....	14·00	14·00	....	....	10 4 3†
Do.	54	Apollo	J. Kitchen & Son Pty., Ltd.	....	....	7·00	....	....	9·00	5·00	14·00	....	....	*
(*b*) *Dried Blood*—														
Dried Blood	17	Cresco	Cresco Fertilisers, Ltd.	....	....	10·50	....	....	....	1·50	1·50	....	....	13 0 0†
(*c*) *Miscellaneous*—														
Garden Manure	56	Sprout-Em	Kag Manufacturing Co.	....	....	....	5·00	....	5·00	4·00	9·00	....	....	Sold in Packets *
Garden Fertiliser	58	Superhumus	Drake & Homer	....	2·00	....	....	1·80	·50	·20	2·50	2·00	....	6d. per lb.
Do. do.	64	Summit Growth Fertiliser Tablets	L. M. McLeod	....	4·10	....	....	7·00	1·20	·10	8·30	12 20	....	1s. per box retail

*Price on application. §As Caustic Potash. ‖Price at Works, Sydney.